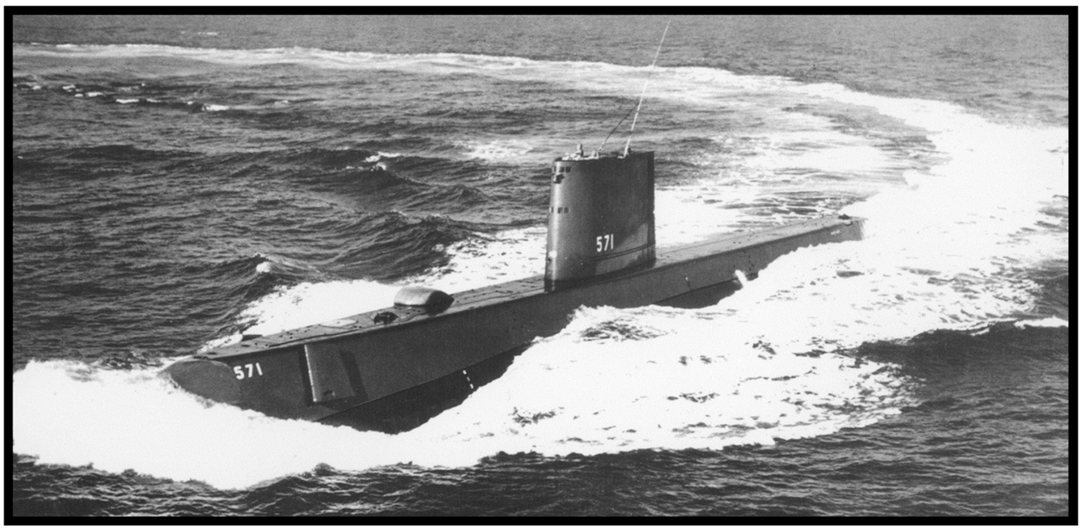
THE UNITED STATES NAVAL NUCLEAR PROPULSION PROGRAM

November 2015

Over 157 Million Miles
Safely Steamed on Nuclear Power



USS NAUTILUS (SSN 571) at Sea
NAUTILUS first went to sea "Underway on Nuclear Power" in 1955

DEPARTMENT OF ENERGY

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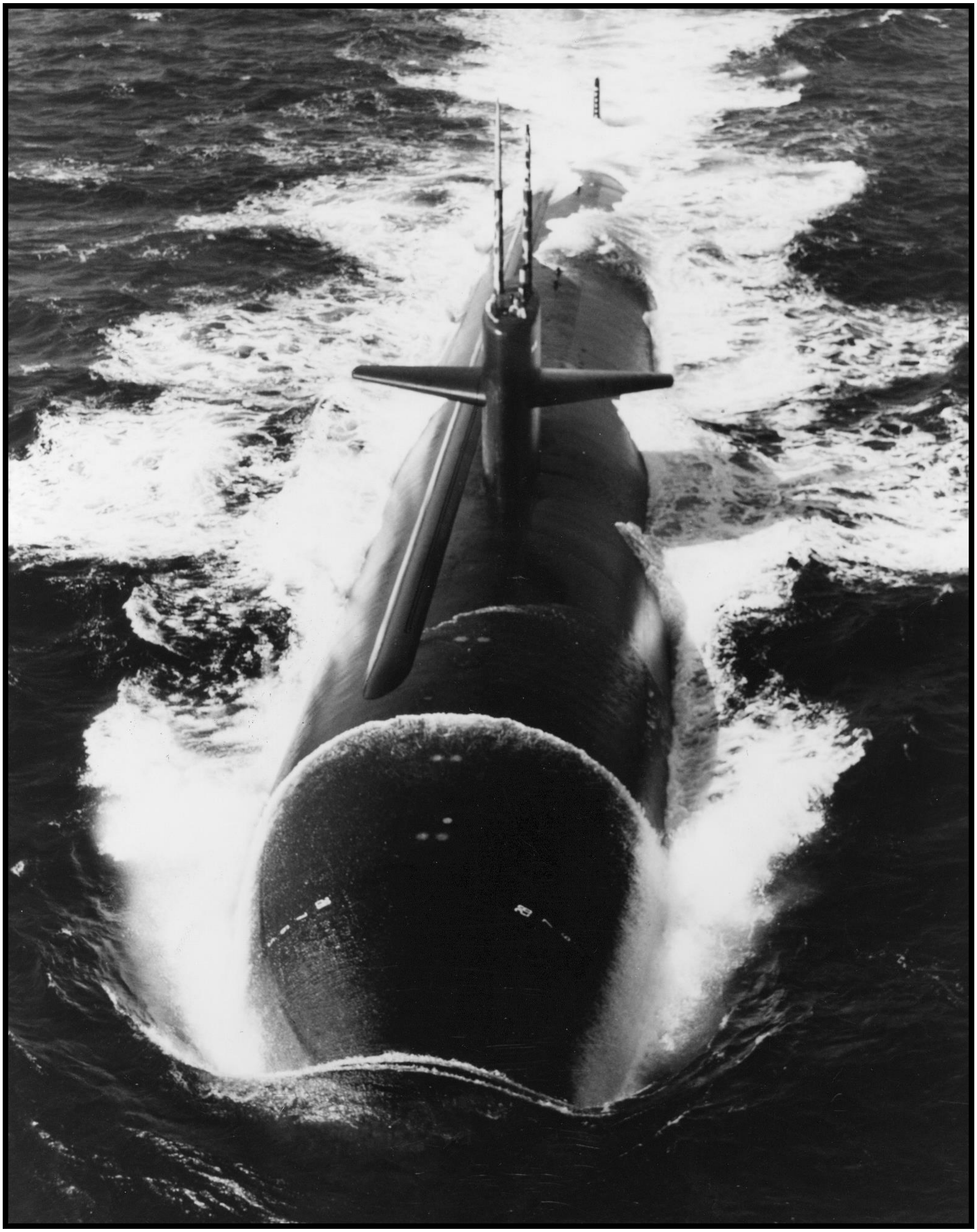
DEPARTMENT OF THE NAVY



THE UNITED STATES

NAVAL NUCLEAR

PROPULSION PROGRAM

United States
of America

Congressional Record

PROCEEDINGS AND DEBATES OF THE 105TH CONGRESS, SECOND SESSION

Vol. 144 WASHINGTON, FRIDAY, JULY 31, 1998 No. 106

THE SENATE RESOLVED THAT:

(1) the Senate commends the past and present personnel of the Naval Nuclear Propulsion Program for the technical excellence, accomplishment, and oversight demonstrated in the program and congratulates those personnel for the 50 years of exemplary service that has been provided to the United States through the program; and

(2) it is the sense of the Senate that the Naval Nuclear Propulsion Program should be continued into the next millennium to provide exemplary technical accomplishment in, and oversight of, Naval nuclear propulsion plants and to continue to be a model of technical excellence in the United States and the world.

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USS NAUTILUS launching ceremony
January 21, 1954

Naval Nuclear Propulsion Program

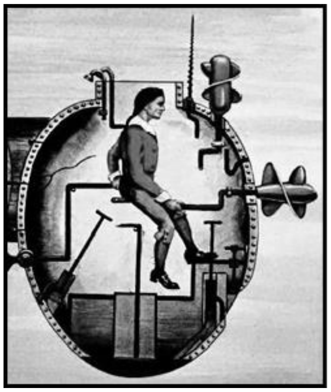
A strong Navy is crucial to the security of the United States, a nation with worldwide interests which conducts the vast majority of its trade via transoceanic shipment. Navy warships are deployed around the world every hour of every day to provide a credible "forward presence," ready to respond on the scene wherever America's interests are threatened. Nuclear propulsion plays an essential role in this, providing the mobility, flexibility, and endurance that today's smaller Navy requires to meet a growing number of missions. More than 45 percent of the Navy's major combatants are nuclear-powered: 10 aircraft carriers, 55 attack submarines, and 18 strategic submarines — 4 of which were converted to a covert, high-volume, precision strike platform designated as SSGN.

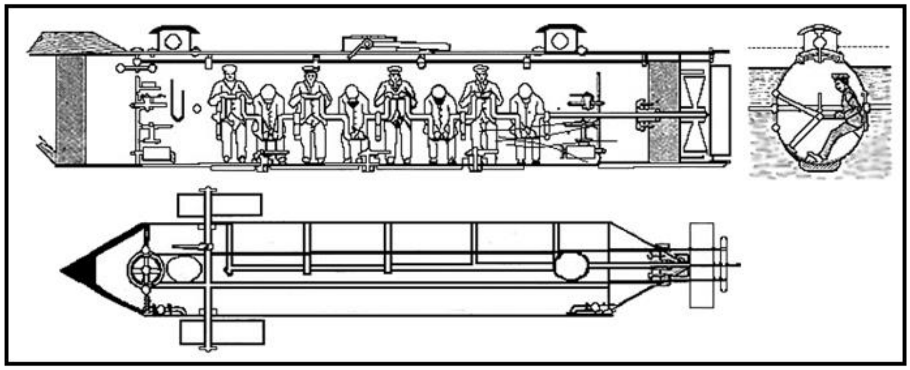
The mission of the Naval Nuclear Propulsion Program, also known as Naval Reactors, is to provide militarily effective nuclear propulsion plants and ensure their safe, reliable, and long-lived operation. This mission requires the combination of fully trained U.S. Navy men and women with ships that excel in endurance, stealth, speed, and independence from logistics supply chains.

Naval Reactors organic statute, 50 U.S.C. §§ 2406, 2511, codifying Presidential Executive Order 12344 set forth the total responsibility of Naval Reactors for all aspects of the Navy's nuclear propulsion, including research, design, construction, testing, operation, maintenance, and ultimate disposition of naval nuclear propulsion plants. The Program's responsibility includes all related facilities, radiological controls, environmental safety, and health matters, as well as selection, training, and assignment of personnel. All of this work is accomplished by a lean network of dedicated research laboratories, nuclear-capable shipyards, equipment contractors and suppliers, and training facilities that are centrally controlled by a small headquarters staff. The Director, Naval Reactors, is Admiral James F. Caldwell, Jr., who also serves as a Deputy Administrator in the National Nuclear Security Administration.

Naval Reactors maintains an outstanding record of over 157 million miles safely steamed on nuclear power. The Program currently operates 96 reactors and has accumulated over 6,700 reactor-years of operation. A leader in environmental protection, the Program has published annual environmental reports since the 1960s, showing that the Program has not had an adverse effect on human health or on the quality of the environment. Because of the Program's demonstrated reliability, U.S. nuclear-powered warships are welcomed in more than 150 ports of call in over 50 foreign countries and dependencies.

Since USS NAUTILUS (SSN 571) first signaled "**UNDERWAY ON NUCLEAR POWER**" over 60 years ago in 1955, our nuclear-powered ships have demonstrated their superiority in defending the country — from the Cold War to today's unconventional threats, to advances that will ensure the dominance of American seapower well into the future.



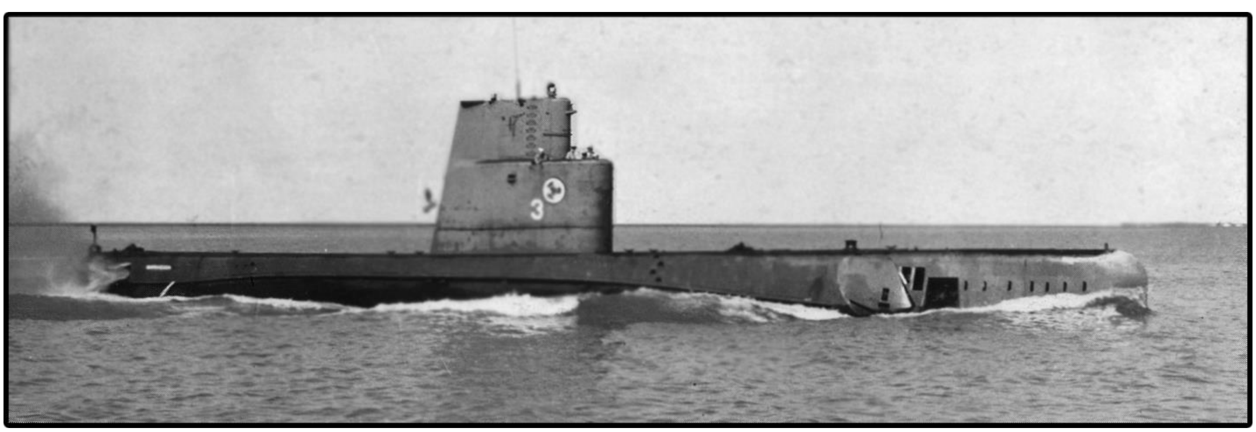


Bushnell's Turtle *CSS H. L. Hunley*

Advantages of Naval Nuclear Power

Submarines: Before the advent of nuclear power, the submarine was, in reality, a small surface ship that could submerge only for short periods of time. The earliest versions of the submarine, Bushnell's *Turtle* (ca. 1775) and the Confederate *CSS H. L. Hunley* (ca. 1864), were propelled by human effort and were limited by human endurance and the amount of oxygen within the vessel upon submergence. Later versions of the submarine required oxygen and fossil fuel to operate engines, which in turn required drawing air in and blowing combustion products out. This meant the submarine had to be either on — or close enough to — the surface to use a snorkel, which made the ship susceptible to detection. To avoid detection, the ship had to submerge and rely on electric batteries, which depleted within several hours. The ship would then have to surface or snorkel again to start the diesel and recharge the batteries.

Although diesel submarines can be relatively quiet when submerged on batteries, they have very limited endurance and power. There are other forms of air-independent propulsion that allow submarines to be submerged for weeks at a time — if they remain at very low speeds. However, because of the large amount of oxygen that must be stored onboard, these propulsion systems are insufficient for warships contributing to global maritime influence.



Diesel Submarine USS BARRACUDA (SST 3)

By eliminating the need for oxygen for propulsion, nuclear power offers a way to drive a submerged submarine at high speeds without concern for fuel consumption, to operate fully capable sensors and weapons systems during extended deployments, and to support a safe and comfortable living environment for the crew. Only a nuclear-powered submarine can operate anywhere in the world's oceans, including under the polar ice, undetected and at maximum capability for extended periods. Further, nuclear power provides endurance at high speeds, allowing strategic changes of missions from one location to another.

USS ENTERPRISE (CVN 65), USS LONG BEACH (CGN 9), and USS BAINBRIDGE (CGN 25) underway as part of Operation ***Sea Orbit***

Aircraft Carriers and Cruisers: With high-speed endurance to provide strategic flexibility; speed and responsiveness to provide tactical flexibility; and mobility while on-station, nuclear-powered aircraft carriers can respond to crises more quickly, arrive in a higher condition of readiness, and stay on-station longer with less logistics support than their fossil-fueled counterparts. Nuclear propulsion in aircraft carriers greatly enhances their military capability. Mobility and security of fuel supplies are among a Fleet commander's greatest concerns. Nuclear propulsion dramatically reduces these concerns by providing the ship virtually unlimited high-speed propulsion endurance without dependence on fossil-fuel tankers or their escorts. As an example, USS ENTERPRISE (CVN 65), USS LONG BEACH (CGN 9), and USS BAINBRIDGE (CGN 25) departed the Mediterranean on July 31, 1964, for a 65-day, 30,000-mile cruise around the world, which was carried out completely free from refueling or logistics support.

Moreover, the compact, energy-dense nature of a nuclear propulsion plant eliminates large-volume tankage requirements for propulsion fuel and reduces space devoted to combustion air and exhaust. This permits increased storage capacity for combat consumables (weapons, aircraft fuel, stores), which improves sustainability and reduces underway replenishment requirements.

Today's Mission

The Naval Nuclear Propulsion Program exists to provide the United States with the most capable warships in the world.

Nuclear-Powered Submarines

Since NAUTILUS, follow-on classes of ever more capable U.S. *nuclear-powered attack submarines* (SSNs) have ensured a warfighting edge over any potential adversary. Forward-deployed SSNs — either alone and unsupported or with strike groups — can exert influence throughout the world, safeguarding vital commercial sea-lanes, protecting aircraft carrier and expeditionary strike groups, and creating tactical uncertainty for an enemy who must tie up his own fleet units in defensive roles. Our SSNs operate virtually undetected in all the world's oceans, even under the Arctic ice. Cruise missiles launched from an unseen, submerged SSN can reach targets deep inland. Perhaps most important, SSNs guarantee *access* — access to hostile areas for intelligence gathering, as well as "clearing the way" to ensure access for other U.S. naval forces. With fewer bases overseas and decreasing Fleet assets, our SSNs represent a stealthy, far-reaching force that will be called upon to shoulder a large part of the defense burden, even in low-intensity conflicts. SSNs provide real-time, actionable intelligence to combatant commanders, and can quickly strike with precision or deploy special forces. Simply put, no other warfighting platform can match the stealth, endurance, mobility, and the mix of capabilities that our SSNs bring to the battle.

USS MISSISSIPPI (SSN 782) returning to Electric Boat after her successful Alpha sea trials

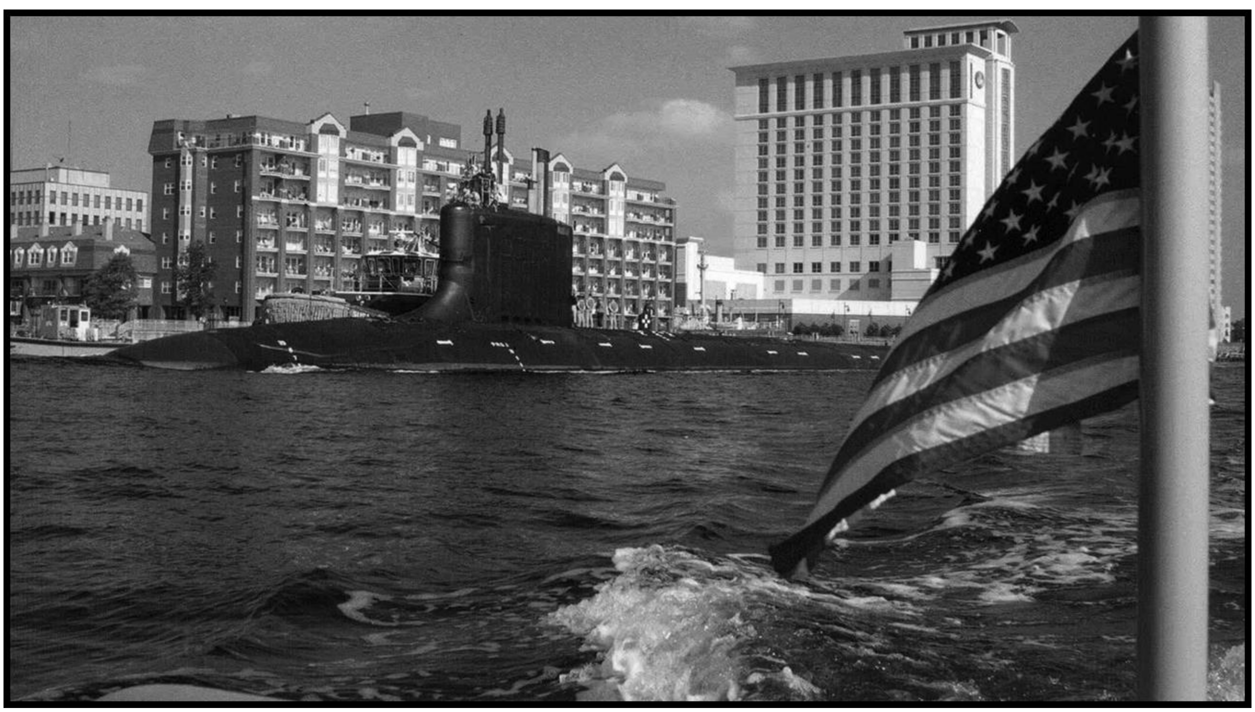
Today's active SSN fleet comprises 40 LOS ANGELES-class SSNs, 3 SEAWOLF-class SSNs, and 12 VIRGINIA-class SSNs.

The VIRGINIA class is the replacement for the LOS ANGELES class, whose earliest boats were commissioned in the 1970s. The lead ship, USS VIRGINIA (SSN 774), was commissioned on October 23, 2004. VIRGINIA is the Navy's first major combatant designed with the post-Cold War security environment in mind, and is uniquely suited for dominance in both shallow and deep waters. VIRGINIA-class submarines can carry out a variety of missions in shallow water near land, from anti-submarine warfare to precision strike, covert intelligence gathering, minefield mapping and mine delivery, and Special Operations Force delivery. These submarines have many innovations, such as an integrated command, control, communications, and intelligence (C3I) system, non-hull-penetrating photonics masts, and a reconfigurable torpedo room to accommodate a large number of Special Operations Force personnel. VIRGINIA-class submarines are equipped with a nine-man lockout chamber and can be equipped with Advanced SEAL Delivery System (ASDS) or Dry Deck Shelter (DDS) for Special Operations Force support.

The number of countries that are seeking or have obtained diesel, air-independent propulsion (AIP), and nuclear-powered submarines is an increasing concern to national security and the military balance in critical regions of the world. The superior stealth, mobility, endurance, and firepower of our SSNs will enable the United States to successfully combat these threats, whether in deep water or in the shallows.

The VIRGINIA-class reactor plant is designed to last the entire planned 33-year life of the ship without refueling. This will help to reduce life-cycle cost while increasing the time the ship is available to perform missions.

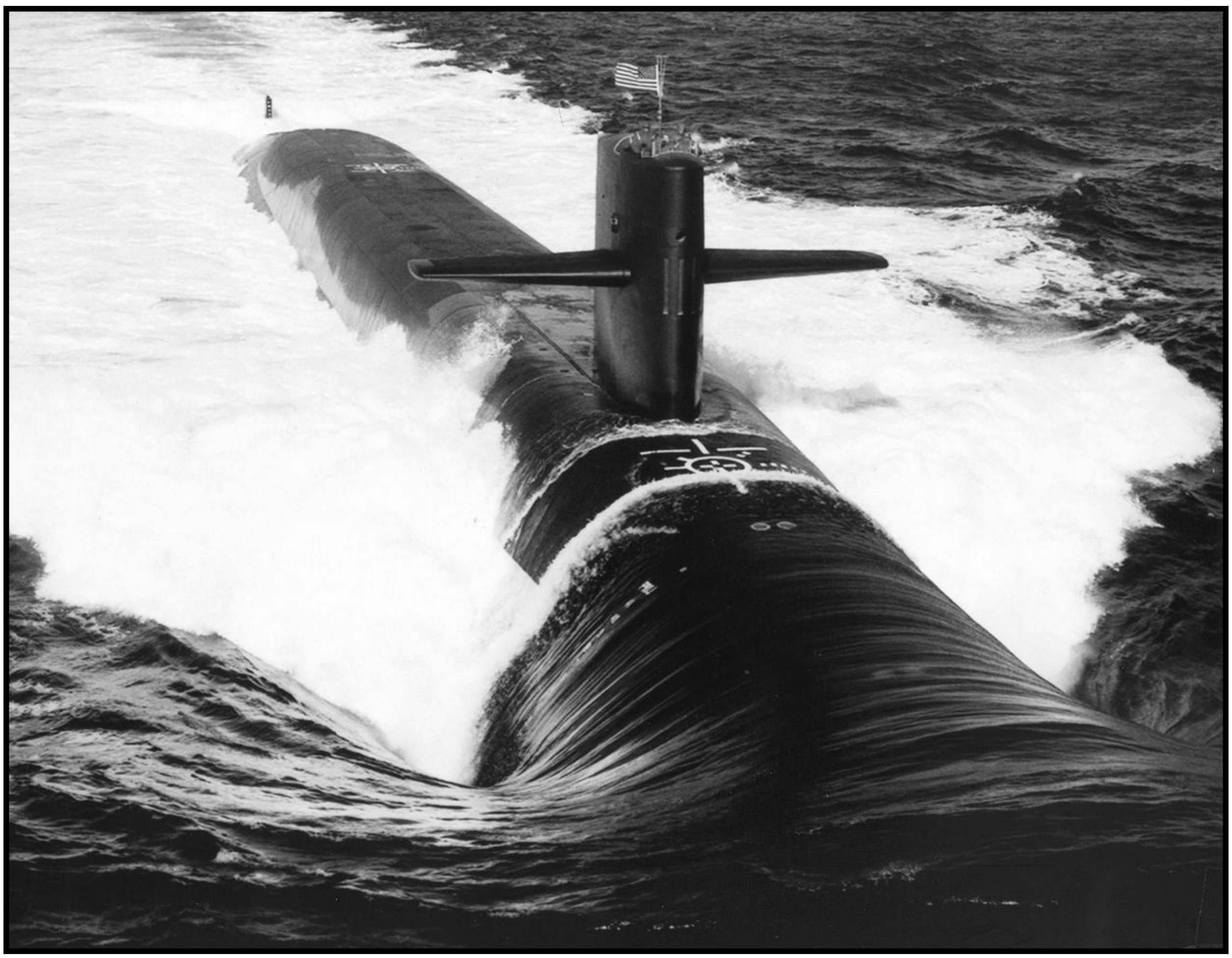
The VIRGINIA-class modular design gives each ship the flexibility to support future technology upgrades and advanced payloads. This flexibility will ensure that these submarines will maintain warfighting superiority over any adversary well into the 21st century.



USS VIRGINIA (SSN 774) passing the skyline of Portsmouth, Virginia, on her way to Norfolk Naval Shipyard after completing Bravo sea trials, August 25, 2004

For over four decades, U.S. *ballistic missile submarines* (SSBNs) have provided strategic deterrence. These warships are virtually undetectable while submerged, forming the most survivable component of the U.S. strategic deterrent. This force is comprised of 14 OHIO-class SSBNs, each capable of carrying 24 *Trident* missiles. At 560 feet in length and 18,700 tons displacement, these OHIO-class SSBNs are the largest U.S. nuclear-powered submarines.

The OHIO-class SSBNs are approaching the end of their service lives and must be replaced. Naval Reactors is working on the design of a new reactor core and propulsion plant to support the next-generation ballistic missile submarine design. The core design is targeted to have a 40 plus-year operational life, which requires extending reactor technologies beyond current 30-year cores. Further, studies and concepts for the plant are focused on both capability and affordability, drawing on existing technologies currently deployed on VIRGINIA-class submarines, as well as new concepts for survivability, integration, automation, and modularity. New technology should provide flexibility for component design and plant arrangements, facilitate lower-cost construction and testing, extend core life, address current and projected threats and reduce life-cycle costs.



USS ALABAMA (SSBN 731)

Four SSBNs no longer needed to perform their strategic deterrence mission have been converted into *nuclear-powered guided missile submarines* (SSGNs). As the Fleet's SSGNs, USS OHIO (SSGN 726), USS MICHIGAN (SSGN 727), USS FLORIDA (SSGN 728), and USS GEORGIA (SSGN 729) are providing new capabilities to submarine commanders.

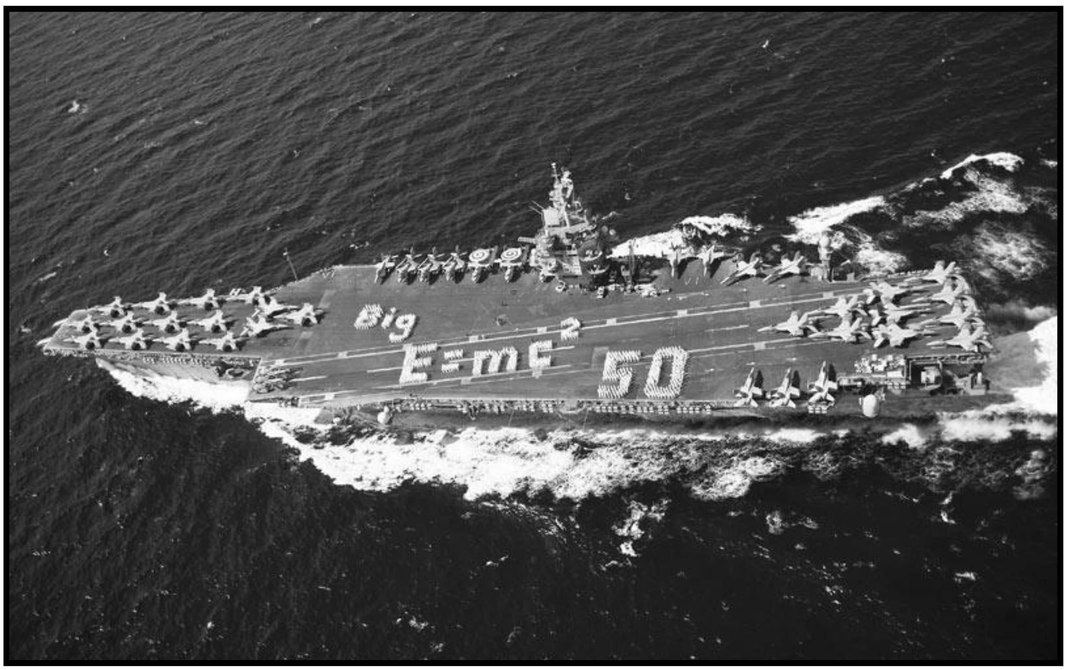
Each of an SSGN's 24 missile tubes has an inside diameter of over 7 feet and can be converted to launch multiple *Tomahawk* guided missiles or to deploy any of a number of large payloads, such as unmanned underwater vehicles (UUVs) and special sensors.

Each SSGN can covertly enter a battlespace carrying unconventional payloads and up to 154 guided missiles, plus a large number of Special Operations Forces personnel. This gives battlefield commanders more surprise strike options, covert information-gathering methods, and communication pathways.

USS OHIO (SSGN 726) with her missile doors open.
OHIO was the first of four SSBNs to complete conversion to SSGN.

Nuclear-Powered Aircraft Carriers

"Where are the aircraft carriers?" is often one of the first questions the President asks in times of crisis around the world. Each aircraft carrier provides the Nation 4½ acres of highly mobile sovereign territory, unconstrained by local host-nation laws and politics, from which to project flexible, rapid, visible, and credible U.S. military power as needed to keep the peace, deter conflicts, protect American interests, or fight a war. Nuclear-powered aircraft carriers (CVNs) can transit to the scene at sustained high speed (without the logistics support that would be needed for a conventional aircraft carrier) and arrive fully ready to launch the awesome firepower of the air wing. They can then sustain that presence and response without immediate replenishment of combat consumables, with tactical mobility and flexibility, free from the need for propulsion fuel replenishment. CVNs have greater fuel-storage capacity to sustain both long-term flight operations and to refuel their conventionally powered escorts, as the logistics dictate.



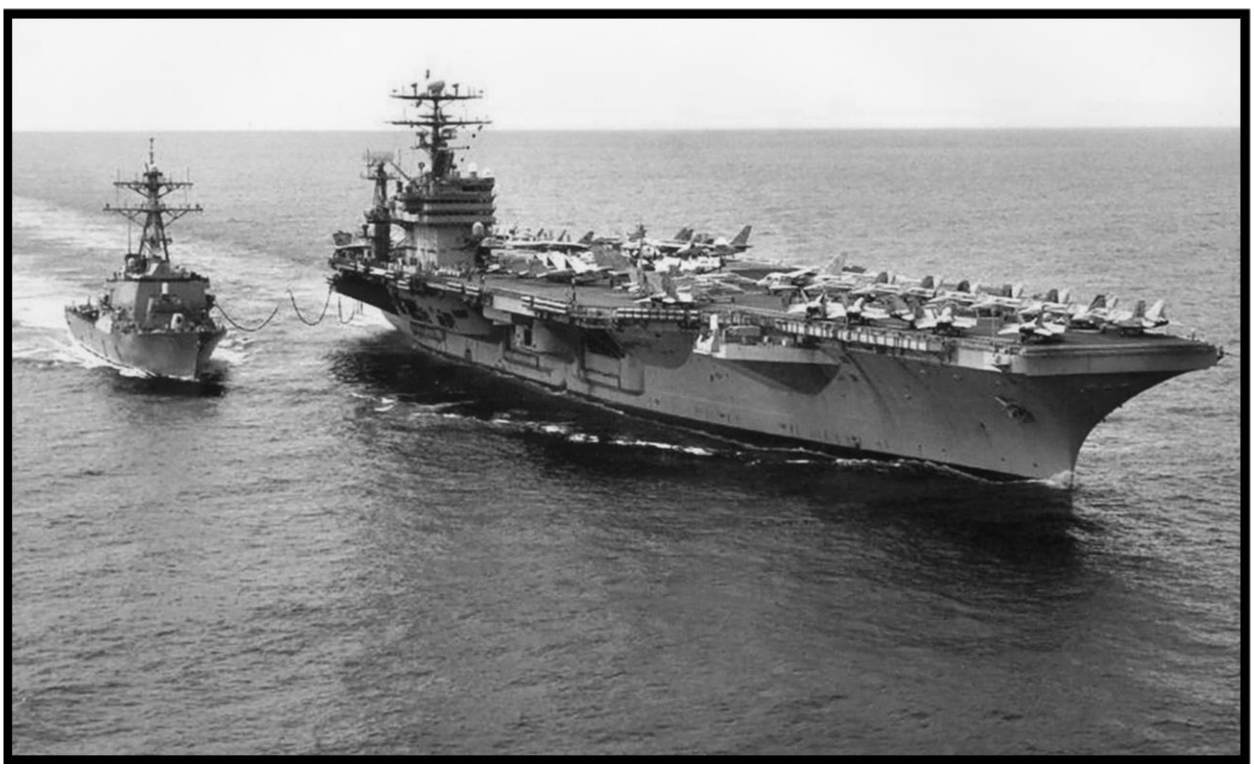
USS ENTERPRISE (CVN 65) celebrating 50 years of service in 2011

Over the last half century, naval nuclear reactors have steamed over 110 million miles with an unmatched, absolutely flawless record of safety and performance. Today, nuclear-powered aircraft carriers reign as the centerpiece of America's strategy of forward presence, and nuclear-powered submarines remain a crown jewel of our Nation's defense arsenal.

— General Henry H. Shelton, U.S. Army
Chairman of the Joint Chiefs of Staff
On the Program's 50th Anniversary, August 1998

Since 1967, when Congress authorized the construction of USS NIMITZ (CVN 68), the Nation has moved toward an all-CVN force. Today, our carrier fleet consists of 10 NIMITZ-class CVNs, with GERALD R. FORD (CVN 78) and JOHN F. KENNEDY (CVN 79) currently under construction. These are the largest warships of any navy in the world. Nuclear propulsion provides unique tactical mobility and flexibility, responsiveness, and sustainability — key attributes in sustaining the ability of our CVN force to meet the demands of forward presence and crisis response in an era of shrinking resources. Thousands of airstrikes in Operations ***Enduring Freedom*** and ***Iraqi Freedom*** were flown from CVNs, hitting targets far inland.

The GERALD R. FORD class represents the convergence of two paths: continuing to provide for current missions while transforming to meet future needs. Significant immediate advances in warfighting capabilities and transformational technologies — embodied in the tripling of electrical power and in increased core energy, coupled with the manpower and planned maintenance cost savings — make developing the GERALD R. FORD class a key investment in 21^{st}-century capability. In addition to the integrated combat system, the GERALD R. FORD class will incorporate a new nuclear propulsion and electric plant. The nuclear propulsion plant will provide increased operational availability, enhanced survivability, improved reliability, a higher quality of life for the crew, greatly reduced acquisition and life-cycle costs, and tremendously improved flexibility for incorporation of warfighting technology envisioned for future ships.

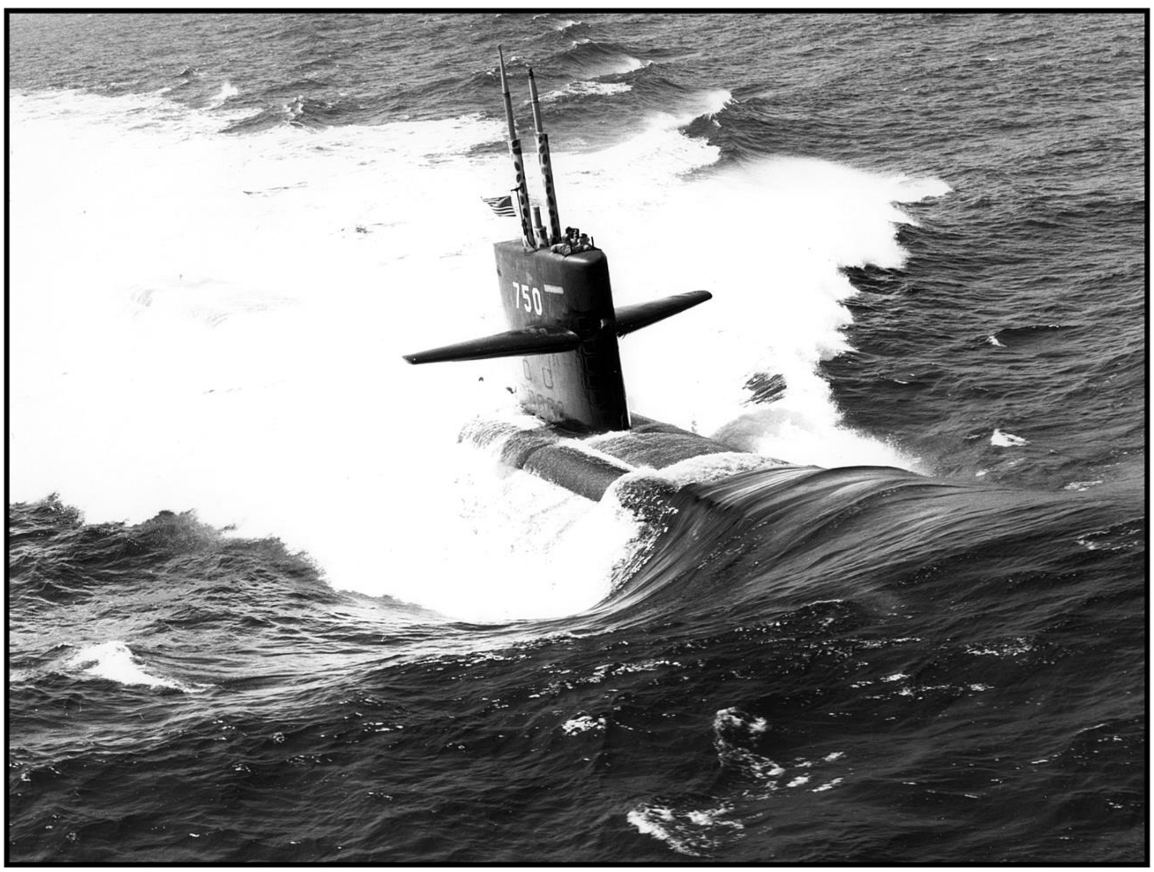


USS CARL VINSON (CVN 70) refueling USS O'KANE (DDG 77)

What is the Naval Nuclear Propulsion Program?

The Naval Nuclear Propulsion Program comprises the military and civilian personnel who design, build, operate, maintain, and manage the nuclear-powered ships and the many facilities that support the U.S. nuclear-powered naval fleet. The Program has cradle-to-grave responsibility for all naval nuclear propulsion matters. Program responsibilities are delineated in 50 U.S.C. §§ 2406, 2511 (codifying Presidential Executive Order 12344 of February 1, 1982). Program elements include the following:

- Research, development, and support laboratories.
- Contractors responsible for designing, procuring, and building propulsion plant equipment.
- Shipyards that build, overhaul, and service the propulsion plants of nuclear-powered vessels.
- Navy support facilities and tenders.
- Nuclear power schools and Naval Reactors training facilities.
- Naval Nuclear Propulsion Program Headquarters and Field Offices.



USS NEWPORT NEWS (SSN 750) on sea trials

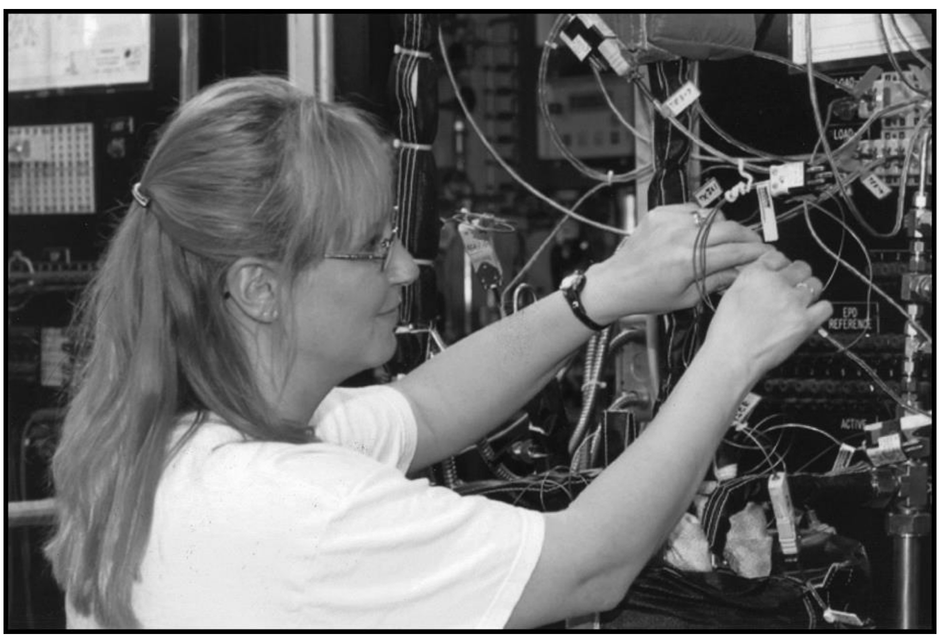
Research, Development, and Support Laboratories

Four government-owned/contractor-operated sites support the Naval Nuclear Propulsion Program: Bettis Atomic Power Laboratory in Pittsburgh, Pennsylvania; Knolls Atomic Power Laboratory (KAPL) in Schenectady, New York; KAPL – Kesselring Site in West Milton, New York; and Naval Reactors Facility within the Idaho National Laboratory.

Bettis and KAPL are research and engineering facilities devoted solely to naval nuclear propulsion work. With combined staffs of over 6,500 engineers, scientists, technicians, and support personnel, their mission is to develop the most advanced naval nuclear propulsion technology and to provide technical support for the continued safe, reliable operation of all existing naval reactors. KAPL also operates two prototype nuclear propulsion plants at the Kesselring Site in New York for the operational testing of new designs and promising new technologies under typical operating conditions before introducing them into the Fleet. Both Bettis and KAPL offer post-graduate research opportunities through the Rickover Fellowship in Nuclear Engineering.[1]

The Naval Reactors Facility, located within the Idaho National Laboratory, examines naval spent nuclear fuel and irradiated test specimens. The data derived from these examinations are used to develop new technology and to improve the cost-effectiveness of existing designs.

The combined efforts of the Program's research, development, and support labs have led to tremendous advances in naval reactor technology. For example, the first submarine core endurance was about 62,000 miles; today, submarine and aircraft carrier cores have an endurance of over 1 million miles.



A technician attaching instrumentation to a materials testing station

[1] For more information, visit the South Carolina Universities Research & Education Foundation website at http://scuref.org/rfp-01

Nuclear Component Procurement Organization

Since the late 1950s, the Naval Nuclear Propulsion Program has had dedicated prime contractor support to provide engineering, procurement, and technical oversight of naval nuclear components. Currently, the prime contractor is Bechtel Plant Machinery, Inc. (BPMI), with locations in Pittsburgh, Pennsylvania, and Schenectady, New York. BPMI is involved in the design, purchase, quality control, and delivery of major propulsion plant components for installation in nuclear-powered aircraft carriers, submarines, and prototype plants.

A technician loading a sample into a gamma spectrometer

Nuclear Equipment Suppliers

A number of privately owned companies throughout the United States perform the actual design and fabrication of the major propulsion plant components. Manufacturing the heavy components used in naval nuclear propulsion plants requires 4-8 years of precision machining, welding, grinding, heat treatment, and nondestructive testing of large specialty metal forgings, under carefully controlled conditions. Standards for naval applications are far more rigorous and stringent than those required for civilian nuclear reactors because components on warships must be designed and built to accommodate battle shock; radiated noise limits; crew proximity to the reactor; and frequent, rapid changes in reactor power. Many of these equipment manufacturers have been supplying the Program for several decades.

USS CITY OF CORPUS CHRISTI (SSN 705) during undocking at Pearl Harbor Naval Shipyard

Shipyards

Two private shipyards build all our nuclear-powered ships. These two shipyards, together with four public shipyards, provide the Nation's capability to overhaul, repair, refuel, and inactivate nuclear-powered ships. These complicated tasks require an experienced and skilled workforce specifically trained to do naval nuclear propulsion work. With approximately 50,000 employees, these six shipyards are unique industrial assets with capabilities found nowhere else in America.

Shipyard	Sector	Location
General Dynamics Electric Boat	Private	Groton, CT
Huntington Ingalls Industries – Newport News Shipbuilding	Private	Newport News, VA
Norfolk Naval Shipyard	Public	Portsmouth, VA
Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility	Public	Pearl Harbor, HI
Portsmouth Naval Shipyard	Public	Kittery, ME
Puget Sound Naval Shipyard and Intermediate Maintenance Facility	Public	Bremerton, WA

Naval Reactors consistently maintains a model program of safe design, construction, operation, and decommissioning of nuclear-powered warships.

— The Honorable A. J. Eggenberger
Chairman, Defense Nuclear Facilities Safety Board
August 8, 2008

Support Facilities and Tenders

Deployed tenders and support facilities at major bases perform maintenance and repair on nuclear-powered ships outside of major shipyard availability periods. Staffed by specially trained personnel, these facilities provide upkeep and resupply support for the Fleet. The tenders are themselves seagoing naval vessels that routinely perform their missions while deployed all over the world. Thus, the ability of the nuclear-powered fleet to remain on-station is further enhanced by the ability to forward-deploy repair and maintenance activities.

USS SALT LAKE CITY (SSN 716) pulling alongside the submarine tender USS FRANK CABLE (AS 40) in Apra Harbor, Guam

Schools and Training Facilities

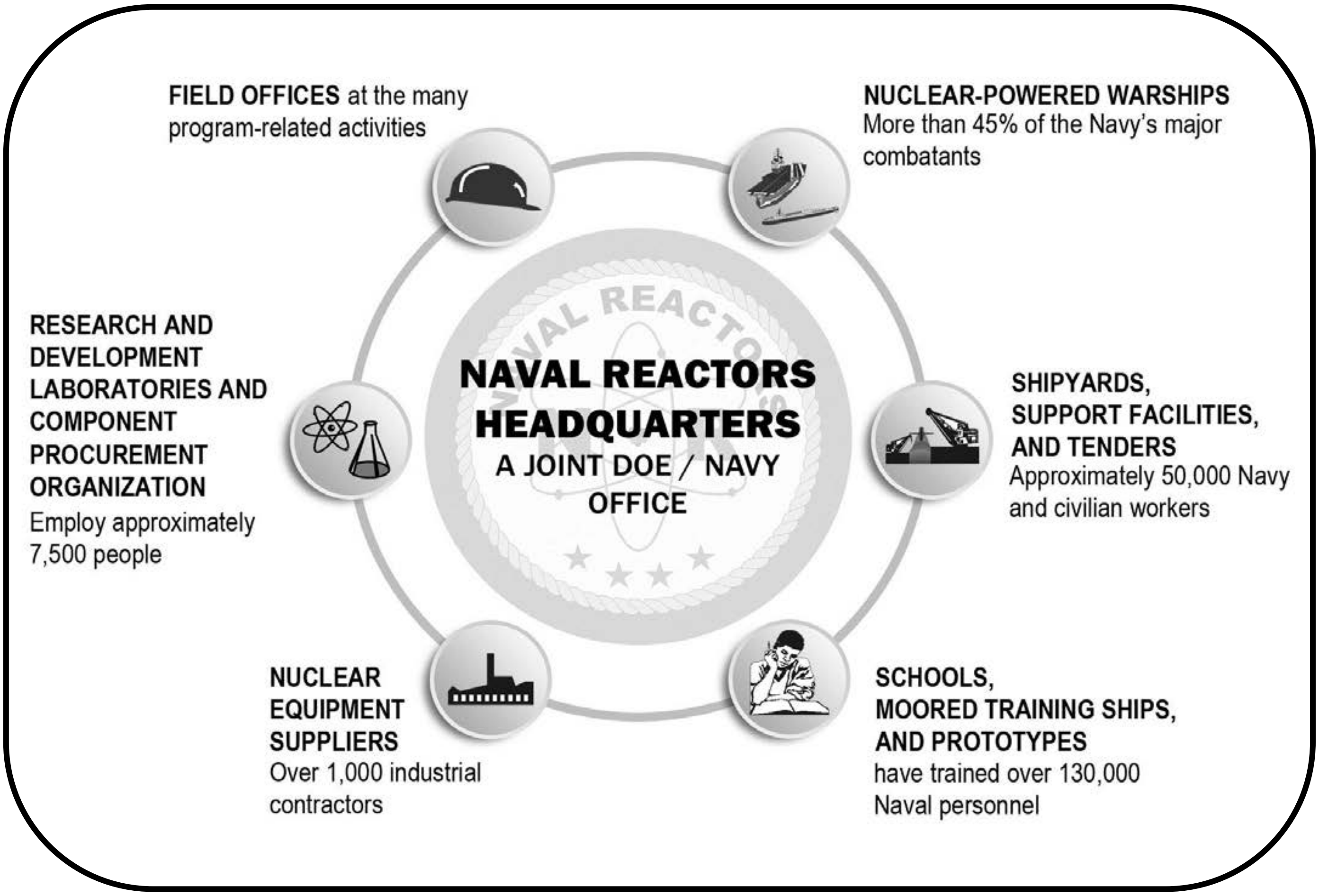
The Naval Nuclear Propulsion Program's unique training requirements are met by special-purpose training facilities staffed by highly qualified instructors. These facilities include the Nuclear Field "A" School and the Nuclear Power School in Charleston, South Carolina; and Moored Training Ships (MTS) and land-based prototypes which provide hands-on training and ensure that, before their first sea tour, all operators have qualified on an operating naval nuclear propulsion plant.

With the repeal of the Combat Exclusion Law in the 1994 Defense Authorization Act and the Navy's decision to open combatant ships to women, the Program began accepting women into the training pipeline to be propulsion plant operators aboard nuclear-powered surface warships. In 2011, women began training to serve aboard submarines.

Enlisted physics class

NAVAL NUCLEAR PROPULSION PROGRAM

Responsible for the research, design, construction, testing, operation, maintenance, and ultimate disposition of naval nuclear propulsion plants



Headquarters

Naval Nuclear Propulsion Program Headquarters provides oversight and direction for all Program elements. Because of the highly complex nature of nuclear technology, all major technical decisions regarding design, procurement, operations, maintenance, training, and logistics are made by a Headquarters staff expert in nuclear technology. Headquarters engineers set standards and specifications for all Program work, while onsite Headquarters representatives monitor the work at the laboratories, prototypes, shipyards, and prime contractors.

Based on over six decades of engineering experience in nuclear propulsion, the Headquarters organization exercises exacting control over all aspects of the Program, demanding technical excellence and discipline unparalleled among nuclear programs.

Establishment of the Program

In 1946, shortly after the end of World War II, Congress passed the Atomic Energy Act, which established the Atomic Energy Commission (AEC) to succeed the wartime Manhattan Project, and gave it sole responsibility for developing atomic energy. At this time, Captain Hyman G. Rickover was assigned to the Navy Bureau of Ships (BUSHIPS), the organization responsible for ship design. Captain Rickover recognized the military implications of successfully harnessing atomic power for submarine propulsion and knew it would be necessary for the Navy to work with the AEC to develop such a program. He and several officers and civilians were sent to the AEC laboratory at Oak Ridge, Tennessee, for a year to learn the fundamentals of nuclear reactor technology.

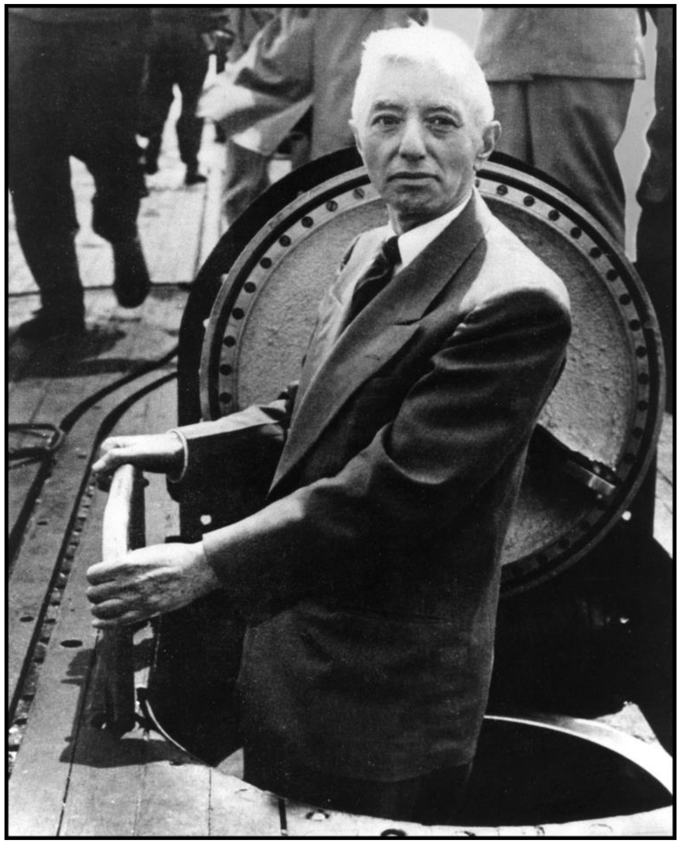
Although the principle of using a reactor to produce heat had long been understood, the technology to build and operate a shipboard nuclear propulsion plant did not exist. There were reactor concepts — several of them; the real challenge was to develop this technology, to transform the theoretical into the practical. New materials had to be developed, components designed, and fabrication techniques worked out. Furthermore, installing and operating a steam propulsion plant inside the confines of a submarine and under the unique deep-sea pressure conditions raised a number of technical difficulties. Faced with these obstacles, the team at Oak Ridge knew that to build a naval nuclear propulsion plant would require a substantial commitment of resources and a new level of Government and Industry commitment.

Captain Rickover returned to Washington and used every opportunity from his post at BUSHIPS to argue the need to establish a Naval Nuclear Propulsion Program. Since there were many unknowns, he recommended that two parallel reactor development projects be undertaken: a pressurized-water cooled reactor and a liquid-metal cooled reactor. On August 4, 1948, the Navy created the new Nuclear Power Branch (Code 390) with Rickover as its head within the Bureau's Research Division.

By 1949, Captain Rickover had forged an agreement between the AEC and the Navy, under which he would proceed with both projects. In 1949, Rickover's new organization contracted with Westinghouse to develop a facility (the Bettis Atomic Power Laboratory) to work on the pressurized-water design. In 1950, he contracted with General Electric to determine whether a liquid-metal reactor design, which it was developing at the AEC's Knolls Atomic Power Laboratory, could be applied to naval propulsion.

Captain Rickover recruited a strong technical staff from those who studied at Oak Ridge, others from past service in the Navy, and top nuclear engineers right out of college. This core of engineers and naval officers oversaw every aspect of the development of nuclear propulsion, including the construction of full-sized prototypes of submarine nuclear propulsion plants.

USS NAUTILUS was built, tested, commissioned, and put to sea in 1955 using the pressurized-water design, as was USS SEAWOLF in 1957, using the liquid-metal design. Although SEAWOLF operated at sea successfully until her first refueling, experience showed that pressurized-water technology was preferable for naval applications. It thus became the basis for all subsequent U.S. nuclear-powered warship designs. In less than 7 years, Captain Rickover obtained congressional support to develop an industrial base in a new technology; pioneered new materials; designed, built, and operated a prototype reactor; established a training program; and took a nuclear-powered submarine to sea. The success and speed of this development revolutionized naval warfare and has ensured America’s undersea and nuclear propulsion superiority ever since.



Admiral Rickover inspecting USS NAUTILUS (SSN 571)

For more than 34 years, Admiral Rickover headed the Naval Nuclear Propulsion Program. Upon retirement in 1982, he left behind a tradition of technical excellence and an organization staffed by experienced professionals dedicated to designing, building, and operating naval nuclear propulsion plants safely and in a manner that protects people and the environment. These traditions have been proudly furthered by his successors. The result is a fleet of nuclear-powered warships unparalleled in capability and a mature, highly disciplined infrastructure of Government and private organizations that continue to build on Admiral Rickover's legacy.

In the 1970s, Government restructuring moved the Naval Nuclear Propulsion Program from the AEC (which was disestablished) to what became the Department of Energy (DOE). In 2000, the Program became a part of the newly formed National Nuclear Security Administration within the DOE. During these transitions, the Program retained its dual agency responsibility and has maintained its basic organization, responsibilities, and technical discipline much as when it was first established.[2]

[2] For a more detailed history of the Naval Nuclear Propulsion Program, see *Nuclear Navy, 1946-1962*, by Richard G. Hewlett and Francis Duncan, 1974, University of Chicago Press (http://energy.gov/management/downloads/hewlett-and-duncan-nuclear-navy-1946-1962), and *Rickover and the Nuclear Navy: The Discipline of Technology*, by Francis Duncan, 1990, Naval Institute Press (http://energy.gov/management/downloads/duncan-rickover-and-nuclear-navy). For more information on Admiral Rickover, see *Rickover: The Struggle for Excellence*, by Francis Duncan, 2001, Naval Institute Press.

Technical and Management Philosophy

Naval nuclear propulsion plants must be militarily capable and reliable in combat, as well as safe for the environment, the public, and those who operate and service them.

The Program has stayed at the forefront of technology to improve tactical speed, silencing, and reliability — characteristics that ensure a commanding edge in warfighting. Naval nuclear propulsion plants are rugged enough to sustain battle shock and keep operating safely; resilient enough to accommodate many years of frequent power changes; and designed to be operated and maintained by a highly trained Navy crew, without onboard scientists and engineers.

Computer network-controlled laser welding containment

The Program's small and relatively uncomplicated pressurized-water reactors are inherently stable and can respond to operational transients without the need for immediate operator action. Fission products are completely contained within high-integrity fuel elements that can withstand high shock loading. The reactor is so effectively shielded that, during a 2-month submerged patrol, a typical submarine propulsion plant operator receives less radiation exposure from the reactor than they would have received from normal background radiation on shore in the same period.

The Naval Nuclear Propulsion Program's success is based on strong central technical leadership, thorough training, conservatism in design and operating practices, and an understanding that in every aspect of the Program, excellence must be the norm.[3] In addition, there is a recognition that individuals must accept responsibility for their actions to maintain these standards. Admiral Rickover said it this way:

> Responsibility is a unique concept: it can only reside and inhere in a single individual. You may share it with others, but your portion is not diminished. You may delegate it, but it is still with you. You may disclaim it, but you cannot divest yourself of it. Even if you do not recognize it or admit its presence, you cannot escape it. If responsibility is rightfully yours, no evasion, or ignorance or passing the blame can shift the burden to someone else. Unless you can point your finger at the person who is responsible when something goes wrong, then you have never had anyone really responsible.

The ship's control party of USS SEAWOLF (SSN 21)

[3] For more on the Naval Nuclear Propulsion Program's technical and management philosophy, see *The Rickover Effect,* by Theodore Rockwell, 1992, Naval Institute Press.

The Training Program

Over 130,000 Nuclear-Trained Sailors

From the inception of the Naval Nuclear Propulsion Program, Admiral Rickover recognized that nuclear propulsion plant operators must know more than simply *what* to do in any given situation: they must understand *why*. Thus, ever since the first crew of USS NAUTILUS reported to the Bettis Atomic Power Laboratory for nuclear training in July 1952, these sailors have received in-depth technical training, both theoretical training and actual watchstanding experience under instruction. This training has been given at many different locations over the years, but the commitment to thorough, detailed understanding of the basics of chemistry, physics, thermodynamics, and plant characteristics has remained its foundation. Currently, the number of sailors trained and qualified as nuclear propulsion plant operators is over 130,000.

Rickover Circle on the campus of Naval Nuclear Power Training Command, Charleston, South Carolina, serves as the site for the Naval Nuclear Power Training Unit, Charleston, graduation ceremony, marking 100,000 nuclear-trained sailors, June 1, 2000

Thorough training minimizes problems, results in quick and efficient responses to emergencies, and helps ensure safety. Prospective plant operators must meet tough selection standards and successfully complete extensive nuclear propulsion training and qualification before reporting aboard ship.

After selection for the Naval Nuclear Propulsion Program and completion of basic recruit training, enlisted personnel are assigned to Nuclear Field "A" School in Charleston, South Carolina, for initial in-rate instruction. In addition to a preparatory course in mathematics, each student receives extensive hands-on training in equipment laboratories specially designed to teach required technical skills. The 24-week Nuclear Power School follows, providing basic academic knowledge necessary to understand the theory and operation of a nuclear propulsion plant. The curriculum is presented at the first-year collegiate level and includes thermodynamics, reactor principles, radiological fundamentals, and other specialized subjects.

Rickover Center, Naval Nuclear Power Training Command, Charleston, South Carolina

The maintenance of high standards for the selection, training, and qualification of nuclear personnel is essential. Based on our observations, we conclude that the training of nuclear propulsion plant operators is highly effective.

— George E. Apostolakis, Ph.D.
Chairman, Advisory Committee on Reactor Safeguards
September 2002

Your rigorous training is a shining example of the pursuit of excellence. . . . This dedication to intensive training . . . has made our nuclear navy the best in the world, bar none. . . .

— The Honorable John M. Spratt
U.S. Representative, South Carolina
May 2000

For officers, all of whom are college graduates with technical training, the first step is the 24-week graduate-level course at Nuclear Power School. Here, students receive highly technical instruction covering the prerequisite theory background before they begin hands-on training on an operating reactor plant. Subjects include those in the enlisted curriculum (but taught in greater depth), as well as electrical engineering, reactor dynamics, and other such courses.

After Nuclear Power School, both officers and enlisted personnel are assigned to one of the Program's prototype propulsion plants or Moored Training Ships (MTS) for 24 weeks of additional classroom training and actual watchstanding experience under instruction. Each student qualifies as a propulsion plant operator, attaining extensive watchstanding experience and a thorough knowledge of all propulsion plant systems and their operating requirements. Under the guidance of experienced operator instructors, students learn how to operate a naval nuclear propulsion plant during normal and potential casualty situations. Before reporting aboard ship, they must qualify on their watchstation on an operating reactor.

Nuclear Power School classroom

Nuclear training onboard ship is every bit as demanding as it is at the schools. Newly reporting officers and enlisted personnel must completely requalify as watchstanders and demonstrate their propulsion plant knowledge and operator ability at their new assignment. Even after qualifying, shipboard operators participate in ongoing Engineering Department training lectures, plant operational evolutions, and extensive casualty drills.

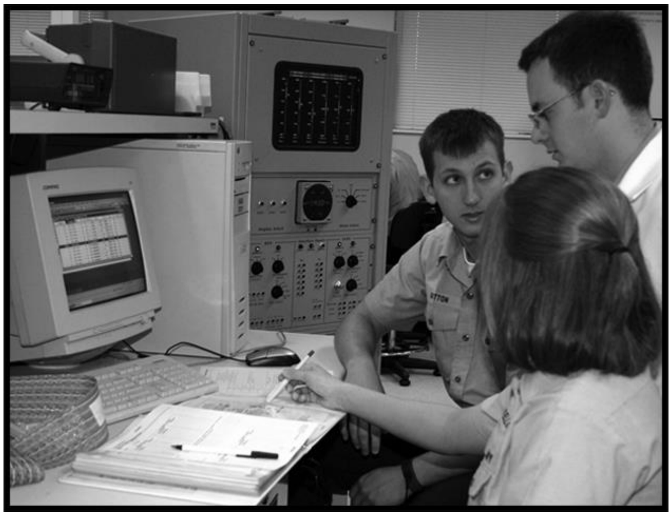
Nuclear Field "A" School training

Since the days of Admiral Rickover, the men and women of the Naval Nuclear Propulsion Program have been recognized around the world for their high standards of achievement and performance, their commitment to professionalism, and their dedication to accountability. Fifty years later, these qualities remain the standard of the Program.

— *The Honorable Dirk Kempthorne*
Governor of Idaho
July 1998

Prototype training

To advance and assume greater responsibility, operators and officers must continue to demonstrate increasing proficiency and knowledge as they qualify and serve on more demanding watchstations. Shore training facilities provide operators advanced training in equipment repair and operation. All officers must qualify as Engineering Officer by passing a comprehensive examination administered by Naval Reactors Headquarters. Additionally, a rigorous advanced training program in nuclear propulsion plant operations is conducted at Naval Reactors Headquarters for prospective commanding officers of nuclear-powered warships, prototypes, and Moored Training Ships (MTS). The course must be completed by any officer taking command of a U.S. Navy nuclear-powered ship.



Nuclear Field "A" School
Instrumentation & Control Lab

Officer chemistry class

Training Is a Way of Life in the Nuclear Navy

Nuclear Power School classroom

Nuclear Field "A" School air compressor lab

What it Means to be a Sailor in the Naval Nuclear Propulsion Program

One of the most rewarding jobs in today's military is that of a sailor in the Naval Nuclear Propulsion Program. Those accepted into this unique Program will face one of the most fulfilling and challenging career paths available. These individuals are intelligent, responsible, and motivated — the Program will accept no less. Since about 45 percent of the Navy's combatants are nuclear-powered, there are many opportunities available to those interested in joining this elite group.

Naval nuclear propulsion plant operators are carefully screened, selected, and trained, and the standards for selection are high. To qualify for the Program, applicants must have (among other prerequisites) a high school diploma or college degree, good academic scores, an interest in pursuing the challenge this highly technical field offers, and the capacity and motivation to work hard.

The training within the Program is respected worldwide; in fact, the quality of this training is recognized to such an extent that many colleges give credit, up to 77 hours, for Program training and experience. After completing initial training, operators continue to gain experience and technical expertise in the many job opportunities onboard nuclear-powered ships. These jobs include operating, maintaining, and repairing equipment; component and system performance testing; standing watches to monitor propulsion plant performance; and eventually supervising and instructing junior personnel in propulsion plant operations.

Nuclear Field "A" School training

Many opportunities are available to sailors who have completed their initial sea tour, such as returning to Nuclear Power School or one of the shore-based training facilities to teach new students; recruiting new sailors for the Program; or working ashore in other commands supporting the Program. Whatever sailors choose to do after their first sea tour, they can be assured that they will be highly sought after because of their training, competence, and professionalism.

There are also monetary benefits in being a part of the Naval Nuclear Propulsion Program. For example, those who are accepted in the Program can receive a generous entry bonus of up to $15,000. After joining, sailors typically advance rapidly and receive more income as a result. Sailors in the Program also receive special duty pay for their unique skills.

The Naval Nuclear Propulsion Program requires mature and dedicated people who are willing to work hard to achieve success. The Program ensures that those who qualify have a firm understanding of science and technology, and the ability and confidence to operate the most advanced nuclear propulsion plants in the world. Sailors who choose this career develop into highly competent, talented, and knowledgeable individuals, and in doing so provide an invaluable service to our country. If you want to be a part of the Naval Nuclear Propulsion Program, please see your local Navy recruiter, call 1-800-USA-NAVY, or go to www.navy.com/nuclear.

Nuclear Field "A" School circuit breaker training

Description of a Typical Naval Nuclear Propulsion Plant

In naval nuclear propulsion plants, fissioning of uranium atoms in the reactor core produces heat. Because the fission process also produces radiation, shielding is placed around the reactor to protect the crew. Despite close proximity to a reactor core, a typical crew member receives less exposure to radiation than one who remains ashore and works in an office building.

U.S. naval nuclear propulsion plants use a pressurized-water reactor design that has two basic systems: the primary system and the secondary system. The primary system circulates ordinary water in an all-welded, closed loop consisting of the reactor vessel, piping, pumps, and steam generators. The heat produced in the reactor core is transferred to the water, which is kept under pressure to prevent boiling. The heated water passes through the steam generators where it gives up its energy. The primary water is then pumped back to the reactor to be heated again.

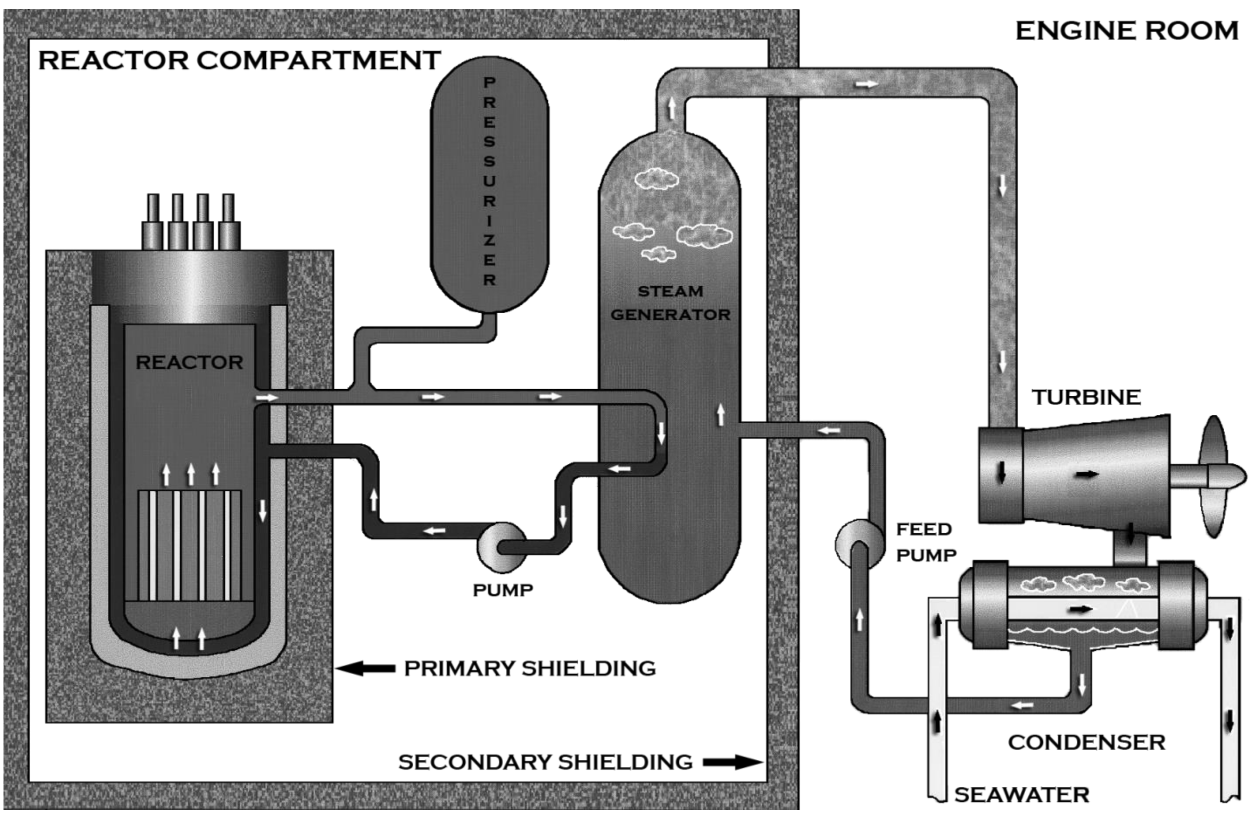
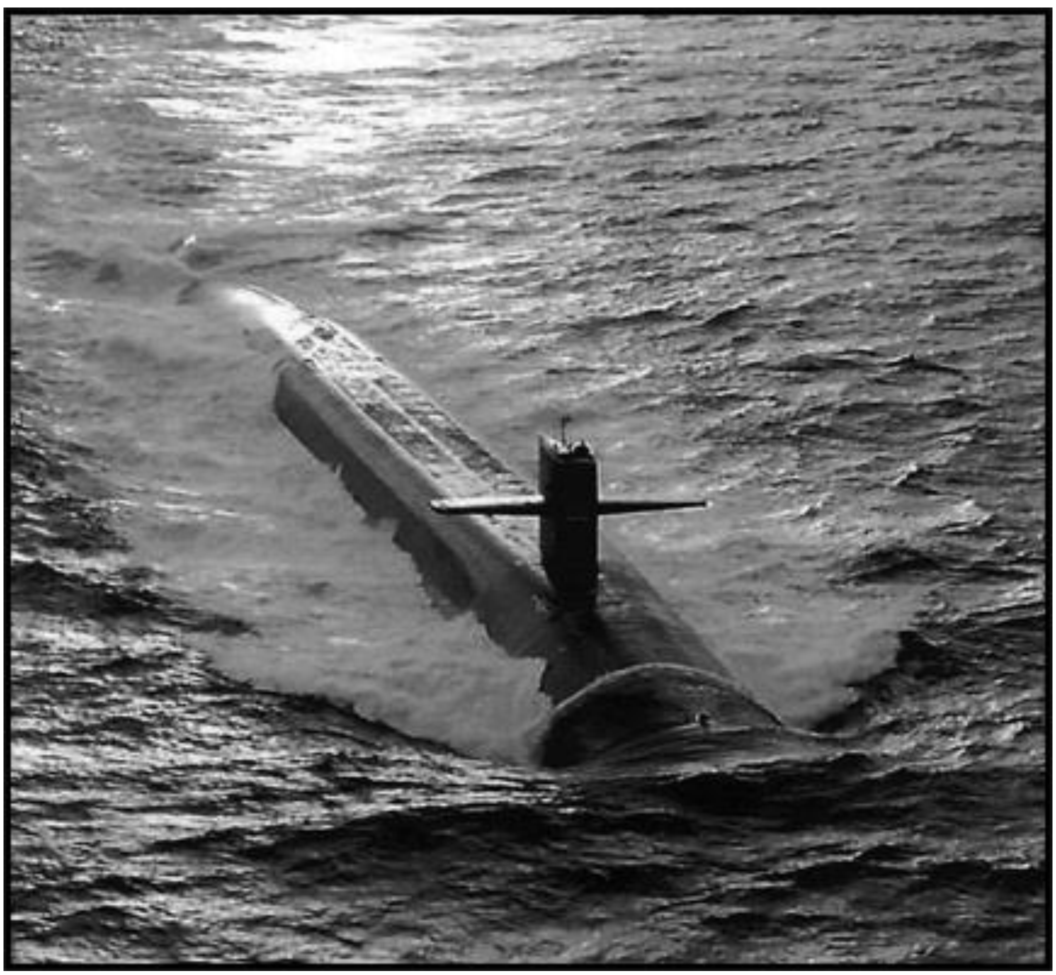


Diagram of a typical naval nuclear propulsion plant

Inside the steam generators, the heat from the primary system is transferred across a watertight boundary to the water in the secondary system, also a closed loop. The secondary water (which is at relatively low pressure) boils, creating steam. Isolation of the secondary system from the primary system prevents water in the two systems from intermixing, keeping radioactivity out of the secondary water.

In the secondary system, steam flows from the steam generators to drive the main propulsion turbines (which turn the ship's propellers) and the turbine generators (which supply the ship with electricity). After passing through the turbines, the steam condenses back into water, and feed pumps return it to the steam generators for reuse. Thus, the primary and secondary systems are separate, closed systems in which continuously circulating water transforms the heat produced by the nuclear reaction into useful work (such as propulsion or electricity).

No step in this power production process requires the presence of air or oxygen. This, combined with the ship's ability to produce oxygen and purified water from seawater for crew needs, allows the ship to operate completely independent of the Earth's atmosphere for extended periods of time. In fact, the length of a submerged submarine patrol is limited primarily by the amount of food the ship can carry for the crew.



USS MAINE (SSBN 741) underway

Protection of People

The policy of the U.S. Naval Nuclear Propulsion Program is to reduce personnel exposure to ionizing radiation associated with naval nuclear propulsion plants to the lowest level reasonably achievable. In carrying out this policy, the Program has consistently maintained personnel radiation exposure standards more stringent than those in the civilian nuclear power industry or in other Government nuclear programs.

No civilian or military personnel in the Naval Nuclear Propulsion Program have ever exceeded the Federal lifetime radiation exposure limit or the Federal annual limit in effect at the time. Since 1968, no personnel have exceeded 5 rem per year, which was the Program's self-imposed limit until it became the Federal limit in 1994. In recent years, the average annual radiation exposure for operators has dropped to about one-tenth of the average annual exposure a member of the American public receives from natural background radiation and medical sources. In 1987, the Yale University School of Medicine conducted an independent study of about 76,000 personnel assigned to submarine duty. In 1991, Johns Hopkins University conducted an independent study of over 70,000 shipyard personnel assigned to work on nuclear-powered ships. Neither study showed any cancer risks linked to radiation exposure.

The principles of personal responsibility, technical knowledge, rigorous training, and auditing are vital to achieving the Program's strong nuclear safety record. These same principles are also applied to Occupational Safety, Health, and Occupational Medical (OSHOM) programs. Workers are provided comprehensive safety and health training, carefully engineered procedures, close supervision, and work-team backup. Inspection, oversight, and feedback mechanisms provide continual improvement and a safer working environment, as witnessed at the Program's laboratories and prototype training facilities, where *injury and illness incidence rates* and *lost workdays rates* are about one-fifth the rates of general industry.

> In light of the September 11 terrorist acts, the use of nuclear-powered ships is now even more critical in defending our country. I am pleased that your program maintains a readiness while controlling risks and enhancing a culture of responsibility and performance.
>
> *— The Honorable Elaine L. Chao*
> *Secretary of Labor*
> *August 2002*

Concern for the Environment

Long before protection of the environment became a prevalent endeavor, it was a high priority in the Naval Nuclear Propulsion Program. From the beginning, the Program recognized that the environmental safety of operating U.S. nuclear-powered ships would be key to their acceptance at home and abroad. The Program maintains the same rigorous attitude toward the control of radioactivity and protection of the environment as it does toward reactor design, testing, operation, and servicing. As a result, the Program has a well-documented record showing the absence of any adverse environmental effect from the operation of U.S. nuclear-powered warships. Because of this record, these ships are welcome in over 150 ports in over 50 countries and dependencies, as well as in U.S. ports.

Environmental releases, both airborne and waterborne, are strictly controlled. As a result, the annual releases of long-lived gamma radioactivity from *all* Program activities are comparable to the annual releases from a typical U.S. commercial nuclear reactor operating in accordance with its NRC license. Throughout the Program's entire history — over 6,700 reactor years of operation and more than 157 million miles steamed on nuclear power — there has never been a reactor accident, nor any release of radioactivity that has had an adverse effect on human health or the quality of the environment. The Program's standards and record surpass those of any other national or international nuclear program.

While providing warfighting advantages when compared to conventionally-powered ships, the operation of a naval nuclear-powered ship also avoids releasing significant amounts of greenhouse gases to the environment. For example, a 1996 Government Accountability Office report determined that an aircraft carrier powered by fossil fuel burns approximately 500,000 barrels of oil per year. This, in turn, generates approximately 240,000 metric tons of carbon dioxide, equivalent to the amount of carbon dioxide generated annually by almost 40,000 passenger vehicles. Since the U.S. Navy has 10 nuclear-powered aircraft carriers and 73 submarines, the amount of carbon dioxide avoided annually by naval nuclear-powered warships is equivalent to over 800,000 passenger vehicles.

The Program has a comprehensive environmental monitoring program at each of its major installations and facilities, including nuclear-capable shipyards and the homeports of nuclear-powered ships. This monitoring program consists of analyzing water, sediment, air, and marine samples for radioactivity to verify that Program operations have not had an adverse effect on the environment. Independent surveys conducted by the EPA and by State and local governments confirm that U.S. naval nuclear-powered ships and support facilities have had no discernible effect on the radioactivity of the environment.

Environmental monitoring at Puget Sound Naval Shipyard

In the field of nuclear energy, not only has naval nuclear propulsion made a contribution to national security of incalculable value, but has done so with a level of sustained excellence that is an outstanding example of Government serving its citizens. The Program's record of safety and environmental protection, started long before it was generally recognized how important these things are, is simply without equal.

— Vice President Albert H. Gore, Jr.
on the Program's 50th Anniversary
August 1998

Ensuring proper environmental performance has also been a priority at Program DOE facilities, which are responsible for non-nuclear as well as nuclear environmental matters. Regular inspection of the Program's laboratory and prototype sites by the EPA and state officials in accordance with the Clean Air Act, the Resource Conservation and Recovery Act (RCRA), and the Clean Water Act, has shown no significant problems.

The Program's stewardship of the environment does not end when a facility ceases operations. For example, the Program has successfully released three former shipyards for unrestricted future use with respect to Program radioactivity: Ingalls Shipbuilding's radiological facilities in Pascagoula, Mississippi (1982), and the Charleston and Mare Island Naval Shipyards in South Carolina and California (1996). These facilities' unrestricted releases from Program radiological controls were independently verified and agreed with by the respective States and the EPA. The successful inactivation and closure of these radiological facilities demonstrates that the stringent control exercised by the Program since its inception has been successful in protecting human health and the environment.

In October 2006, the U.S. Naval Nuclear Propulsion Program commemorated the first-ever unrestricted release of a U.S. nuclear power reactor site, based on the absence of both chemical and radiological constituents. After operating for 34 years and training over 14,000 sailors, the DOE S1C Prototype Reactor Site in Windsor, Connecticut, was returned to "green-field" conditions. Naval Nuclear Propulsion Program personnel and contractors worked in cooperation with the Connecticut Department of Environmental Protection, the U.S. Environmental Protection Agency, the town of Windsor, and the public to complete this project. These agencies also provided independent oversight of the project. The current Windsor Site condition makes it suitable for any future use, without restriction, from economic development to recreation.

S1C Prototype in the early 1980s

S1C Prototype after unrestricted release, October 2006

Finally, the Program maintains its environmental responsibilities from cradle-to-grave — from nuclear-powered warship design to ultimate disposal. The U.S. Navy's program to safely dispose of decommissioned nuclear-powered submarines and cruisers is an example. It involves defueling the reactor(s), inactivating the ship, removing the reactor compartment for land disposal, recycling the remainder of the vessel to the maximum extent practical, and disposing of the remaining non-recyclable materials. The spent nuclear fuel removed from nuclear-powered warships constitutes about 0.05 percent of all spent nuclear fuel in the United States today. Also, it is ruggedly designed to withstand combat conditions, and can be safely stored pending ultimate placement in a geologic repository. The Program has safely made 844 container shipments of naval spent nuclear fuel since 1957 using specially designed, rugged containers, such as the M-140 pictured below. To date, 118 nuclear-powered warships have been recycled with 127 defueled reactor compartments sent to the DOE's Hanford Site, as shown on the next page.

M-140 shipping container mounted on railcar

> The fact that the Navy has always had unrestricted use as their goal is a real tribute to the Navy and the ethic that exists about leaving behind a site that is as clean as or cleaner than the one that they took control over when they first came here.
>
> *— Mr. Robert W. Varney*
> *Region 1 Administrator, U.S. Environmental Protection Agency*
> *October 2006*

Defueled naval reactor compartments at the Department of Energy's Hanford Site, December 2014

Naval Nuclear Propulsion Program
Emergency Preparedness

U.S. nuclear-powered warships are designed to the most exacting and rigorous standards. They are built to survive wartime attack, include redundant systems, and are operated by highly-trained crews using rigorously applied procedures. These features enhance both safety and the ability of the ship to survive attack in time of war.

Naval reactors are designed and operated in such a way as to protect the crew, the public, and the environment. It is important to note that the crew lives in very close proximity to the reactor and is dependent on the energy generated by the reactor for air, water, heat, and propulsion. Thus, it is imperative to both the Navy and the crew that the reactor be well designed and safely operated. An equally important part of ensuring safety is developing, exercising, and evaluating the ability to respond to any emergency in the highly unlikely event one does occur.

Planning for emergencies is based on extensive Naval Nuclear Propulsion Program technical analysis, as well as recommendations and guidance provided by numerous agencies experienced in emergency planning, including the Department of Homeland Security (Federal Emergency Management Agency), the Navy, the Department of Energy, the Nuclear Regulatory Commission, the Environmental Protection Agency, the National Council on Radiation Protection and Measurements, and the International Atomic Energy Agency.

All Naval Nuclear Propulsion Program activities, both shipboard and ashore, have plans in place that define Program responses to a wide range of emergency situations. These plans are regularly exercised to ensure that proficiency is maintained. These exercises consistently demonstrate that Program personnel are well prepared to respond to emergencies regardless of location. Actions are taken to continually evaluate and improve emergency preparedness at all Program activities.

Naval Spent Nuclear Fuel Transportation Exercises

In September 2015, the Naval Nuclear Propulsion Program completed its tenth full-scale naval spent nuclear fuel transportation accident exercise in Granger, Wyoming. This was the first exercise to use an M-290 shipping container. The scenario simulated the collision of a dump truck with a spent nuclear fuel container railcar at a railroad crossing. Navy personnel escorting the shipment practiced verifying that the container was still intact and assisting the local incident commander and emergency responders in their response to the accident. More than 190 people observed and participated in the exercise in Granger, representing several Federal agencies, multiple states and counties and Union Pacific Railroad. These exercises are extremely effective in promoting public knowledge of the safety of the Program's Naval spent nuclear fuel shipments, increasing first responder confidence in their ability to respond to accidents involving these shipments, and providing stakeholders with the opportunity to interact and learn from one another.

Federal, State, and local Wyoming emergency responders address a simulated injury during the most recent naval spent nuclear fuel transportation accident exercise in Granger, Wyoming, on September 17, 2015.

Partnership with State and Local Officials

If a radiological emergency ever occurred, civil authorities would be promptly notified and kept fully informed of the situation. With the support of Naval Nuclear Propulsion Program personnel, local civil authorities would determine appropriate public actions, if any, and transmit this information via their normal emergency communication methods.

The Naval Nuclear Propulsion Program maintains close relationships with civil authorities to ensure that communications and emergency responses are coordinated, if ever needed. Periodic exercises are conducted with all States and Guam where U.S. nuclear-powered warships are homeported and Naval Nuclear Propulsion Program facilities are located, demonstrating the Navy's commitment to work as a team in response to emergency situations.

> The Commission recognizes that since the NAUTILUS first signaled "UNDERWAY ON NUCLEAR POWER" 50 years ago, nuclear-powered warships have steamed many millions of miles and have accumulated thousands of reactor-years of operation without a nuclear accident or any adverse radiological impact on the quality of the environment.
>
> *— The Honorable Nils J. Diaz*
> *Chairman, Nuclear Regulatory Commission*
> *September 2004*

Due to the unique design and operating conditions of U.S. nuclear-powered ships, civil emergency response plans that are sufficient for protecting the public from industrial and natural events (for example, chemical spills or earthquakes) are also sufficient to protect the public in the highly unlikely event of an emergency onboard a nuclear-powered ship or at a Naval Nuclear Propulsion Program facility.

Members of the public who live near nuclear-powered ships or support facilities can be confident that in the event of an emergency, extensive resources are readily available to quickly respond to the situation.

Sailors and emergency response personnel working together during an emergency preparedness exercise at Naval Submarine Base, Groton, Connecticut

Naval Nuclear Propulsion Program Accomplishments

In addition to the military applications of nuclear power, technology developed by the Naval Nuclear Propulsion Program is the basis for civilian nuclear power around the world. Significant contributions include:

- The uranium-dioxide fuel system — now the most widely used system in nuclear power.
- The design for large pressurized-water reactor components and the cladding for large pressure vessels.
- Containment concepts and refueling techniques for power reactors.
- A system for preventing damage to a reactor core even if failures occur in the cooling system.
- The first successful method of radioactive decontamination of reactor plants.
- Zirconium, zirconium alloys, and hafnium materials for cladding and reactor control use.
- Numerous computer programs widely used for design safety, research, and testing.
- The first chemical cleaning process for nuclear plant steam generators.
- Ultrasonic inspection methods for evaluating the material status of the reactor vessel and major components.
- Nuclear fabrication standards, quality control requirements, and equipment specifications.
- Development and publication of the CHART OF THE NUCLIDES, used worldwide for nuclear research and development work.
- Extensive use of solid-state electronics for instrumentation, control, and power distribution.

The Program also gives industry information from its research in a variety of areas, including corrosion and wear technology for components operating in high-temperature, high-pressure water; pressurized-water reactor heat transfer and fluid flow technology; methods for predicting performance of reactors in accident scenarios; and numerical analyses of reactor designs using digital computers. This has resulted in over 5,000 technical reports which have been made available to industry and the public.

Perhaps the most substantial contribution to the civilian sector is the thousands of highly trained Program graduates who now play key roles in operating and managing civilian nuclear power reactors.

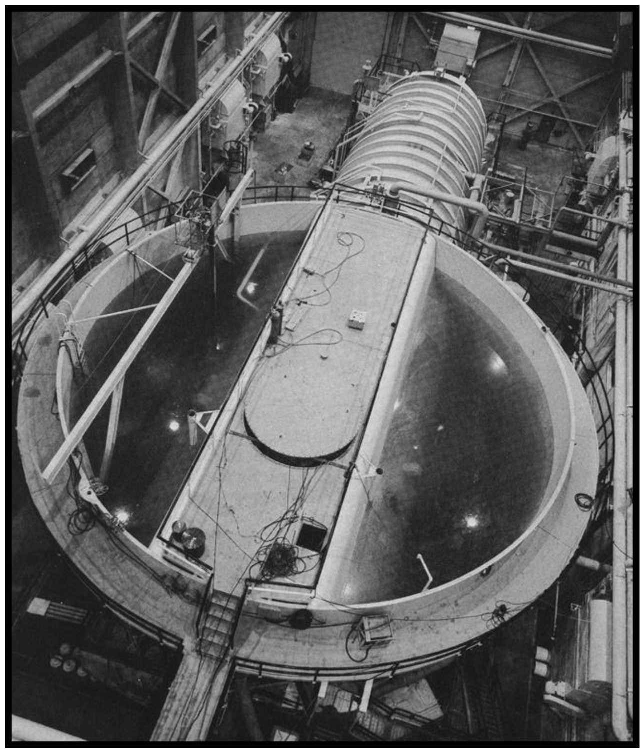
Appendix

The First Naval Nuclear Propulsion Plants

The First Prototype (S1W)

December 1948 The AEC contracts with Westinghouse to design, build, operate, and test a prototype pressurized-water naval nuclear propulsion plant (known alternatively as Submarine Thermal Reactor, Mark 1, or simply S1W).

1950–1953 S1W is constructed at the AEC's National Reactor Testing Station (now DOE's Idaho National Laboratory) inside a submarine hull surrounded by a 300,000-gallon tank of water simulating the ocean.



S1W prototype with water tank to simulate the ocean environment

March 30, 1953 S1W reaches criticality at 11:17 p.m., making the first practical quantities of nuclear power in the world.

June 25, 1953 S1W achieves full design power and begins a successful 96-hour sustained full-power run, simulating a submerged crossing of the Atlantic Ocean.

Late 1955 Following nearly 2 years of continuous operation and testing and a refueling, S1W completes a 66-day continuous full-power run — the equivalent of propelling a submarine at high speed twice around the globe.

October 1989 DOE permanently shuts down S1W after 36 years of safe operation. The last 22 years of operation used the same reactor core, setting a longevity record. Over 13,000 Navy officer and enlisted operators trained at S1W.

USS NAUTILUS (SSN 571)

With the endurance and stealth only nuclear propulsion could provide, NAUTILUS revolutionized undersea warfare by becoming the world's first *true* submarine, limited only by the amount of supplies she could carry.

August 1949 The CNO establishes a January 1955 "ready-for-sea" date for development of a submarine nuclear propulsion plant.

August 1950 President Harry S Truman signs Public Law 674, authorizing construction of NAUTILUS.

August 1951 Electric Boat begins construction of the first nuclear-powered submarine.

June 14, 1952 President Truman lays the keel of NAUTILUS.

September 30, 1954 NAUTILUS is commissioned in Groton, Connecticut.

January 17, 1955 Under the command of Commander Eugene P. Wilkinson, USS NAUTILUS puts to sea for the first time — less than 4 years after construction began — signaling her historic message, "UNDERWAY ON NUCLEAR POWER."

February 1955 In 84 hours, NAUTILUS steams 1,300 submerged miles from New London, Connecticut, to San Juan, Puerto Rico — 10 times farther than previously traveled by a submerged submarine. This is the first time that a submarine maintains a high speed (about 16 knots average) for longer than an hour.

1957 NAUTILUS is refueled after steaming over 62,000 miles on her first core. The submarine was submerged for more than half that distance.

August 3, 1958 During an 1,800-mile, 96-hour historic transpolar voyage from Point Barrow, Alaska, to the Greenland Sea, NAUTILUS becomes the first ship to reach the geographic North Pole. President Eisenhower awards NAUTILUS the Presidential Unit Citation (the first such award in peacetime) for demonstrating the Arctic's strategic potential; and her Commanding Officer, Commander William R. Anderson, the Legion of Merit.

1960 NAUTILUS deploys to the Mediterranean and becomes the first nuclear-powered submarine assigned to the SIXTH Fleet.

1960-1979 NAUTILUS participates in numerous defense missions, including the naval blockade on all offensive military equipment under shipment to Cuba during the 1962 Cuban missile crisis, and demonstrates U.S. technical capability through high-visibility calls in numerous foreign ports in the Atlantic and the Mediterranean.

April 1979 NAUTILUS departs Groton en route to California for her final voyage. Completes her 2,500th dive and 510,000 miles safely steamed on nuclear power.

May 1979 NAUTILUS enters Mare Island Naval Shipyard for inactivation and conversion as a historic ship for public display. Following this, NAUTILUS leaves California under tow for the Naval Submarine Base in Groton.

USS NAUTILUS (SSN 571) pierside at the Submarine Force Library and Museum in Groton, Connecticut, during a ceremony commemorating the 50th anniversary of her commissioning, September 30, 2004

USS NAUTILUS (SSN 571) DATA

Length — 320 feet

Beam — 28 feet

Displacement — Surfaced: 3,533 tons
Submerged: 4,092 tons

Today: NAUTILUS is currently a National Historic Landmark, open to the public as part of the NAUTILUS Memorial and Submarine Force Library and Museum, Groton, Connecticut. (For additional information, write to P.O. Box 571, NAVSUBASE, Groton CT 06349-5000, or view the NAUTILUS Museum website at *http://ussnautilus.org)*.

NAUTILUS Memorial and Submarine Force Library and Museum, Groton, Connecticut

USS SEAWOLF (SSN 575) outbound in San Francisco Bay

USS SEAWOLF (SSN 575)

April 1950 General Electric begins design work on a liquid-sodium naval nuclear propulsion plant as an alternative to pressurized water for a second nuclear-powered submarine — USS SEAWOLF.

September 1953 SEAWOLF's keel is laid at Electric Boat.

June 1956 SEAWOLF's reactor reaches criticality.

October 1958 While operating as an active unit of the Atlantic Fleet, SEAWOLF completes a record-breaking 60-day submerged run, traveling over 13,000 miles.

December 1958 Although operating satisfactorily for almost 2 years, SEAWOLF's sodium-cooled plant is significantly less attractive for naval warships than pressurized-water alternatives. Therefore, the SEAWOLF plant is replaced with a pressurized-water plant (S2W) similar to that installed in NAUTILUS. SEAWOLF's sodium plant had steamed over 71,000 miles, submerged for over three-quarters of that distance.

March 1987 SEAWOLF is decommissioned after 30 years of operation and over 473,000 miles safely steamed on nuclear power.

Classes of Nuclear-Powered Ships

Submarines

Early SSNs: With the success of NAUTILUS, the Navy launched a series of attack submarine classes (SKATE, SKIPJACK, and PERMIT) that introduced different warfighting and design features.

USS SHARK (SSN 591) on sea trials

USS SHARK (SSN 591) DATA
(SKIPJACK class)

Length — 249 feet

Beam — 32 feet

Displacement — Surfaced: 3,075 tons
Submerged: 3,500 tons

Fleet Ballistic Missile (FBM) Submarines: With NAUTILUS still in operational testing, the Navy began developing a submarine ballistic missile system, which it brought from inception to deployment in 5 years. In the first class of FBMs (GEORGE WASHINGTON), the Navy extended SSN hulls to add a missile compartment amidships. In the 1960s, subsequent FBM classes (ETHAN ALLEN, LAFAYETTE, JAMES MADISON, and BENJAMIN FRANKLIN) were designed from the keel up as missile submarines. Each carried 16 *Polaris* missiles, but were later backfitted with the more powerful and accurate *Poseidon* missile. A few of the JAMES MADISON- and BENJAMIN FRANKLIN-class submarines were also backfitted with the early *Trident I* ballistic missiles. All submarines of these classes have now been retired from strategic service and replaced by the more advanced OHIO-class ballistic missile submarines, which carry *Trident II* missiles.

USS ALEXANDER HAMILTON (SSBN 617)

USS ALEXANDER HAMILTON (SSBN 617) DATA
(LAFAYETTE class)

Length — 425 feet

Beam — 33 feet

Displacement — Surfaced: 7,250 tons
Submerged: 8,250 tons

USS HAMMERHEAD (SSN 663)

USS HAMMERHEAD (SSN 663) DATA
(STURGEON class)

Length — 292 feet

Beam — 32 feet

Displacement — Surfaced: 4,250 tons
Submerged: 4,780 tons

USS STURGEON (SSN 637) class: After deployment of PERMIT-class submarines, the Navy began building STURGEON-class submarines, which combined the most advantageous warfighting elements of the early SSN classes. With well-tested, quiet, and dependable propulsion plants, the 37 STURGEON-class submarines were the mainstay of our nuclear fleet into the 1980s.

Single-ship Designs: The Navy built several single-ship class submarines — USS TRITON (SSN 586), USS HALIBUT (SSN 587), USS TULLIBEE (SSN 597), USS NARWHAL (SSN 671), and USS GLENARD P. LIPSCOMB (SSN 685) — each to explore alternate propulsion plant concepts (for example, turbine electric drive and different reactor and propulsion turbine designs). Technology developed in these efforts became the basis for later classes.

USS LOS ANGELES (SSN 688) class: With a high-power propulsion plant, advanced sonar, and improved torpedo fire control systems, LOS ANGELES-class submarines provide high-speed escort, anti-submarine and anti-surface warfare roles with a minimum underwater noise signature. Beginning with USS SAN JUAN (SSN 751), LOS ANGELES-class submarines incorporate technological advances, including cruise missile vertical launch capability, a new combat system, and retractable bow planes. Additionally, these later boats do not need to be refueled over the entire life of the ship. The LOS ANGELES class currently makes up more than 70 percent of our fast-attack boats.

USS ALBANY (SSN 753)

USS ALBANY (SSN 753) DATA
(LOS ANGELES class)

Length — 362 feet

Beam — 33 feet

Displacement — Surfaced: 6,000 tons
Submerged: 6,927 tons

USS PENNSYLVANIA (SSBN 735)

USS PENNSYLVANIA (SSBN 735) DATA
(OHIO class)

Length — 560 feet

Beam — 42 feet

Displacement —	Surfaced:	16,600 tons
	Submerged:	18,700 tons

***Trident* Ballistic Missile Submarines:** Virtually undetectable in the open ocean, *Trident* submarines are quieter, better equipped, and have greater missile range than their predecessors. With an advanced design, a long-life reactor plant, and a unique, comprehensive program to ensure equipment reliability and material availability, *Trident*s operate for long periods between servicings. *Trident*'s 560-foot length provides room to incorporate future modifications and technological developments. Large hatches and a carefully planned equipment arrangement facilitate component servicing and replacement. This class comprises 14 ships.

Guided Missile Submarines: Four ballistic missile submarines have been converted into guided missile submarines (SSGNs). Each SSGN is capable of covertly entering a battlespace carrying unconventional payloads and up to 154 guided missiles, plus a large number of Special Operations Forces personnel. This capacity gives battlefield commanders more surprise strike options, clandestine information-gathering methods, and communication pathways.

USS SEAWOLF (SSN 21) class: The SEAWOLF class goes faster, dives deeper, and carries significantly more weapons than its predecessors. The technology developed for SEAWOLF — enabling a high power-density propulsion plant that can operate quietly over the ship's entire speed range — is being applied to future generations of nuclear-powered warships.

The newest and last of the SEAWOLF class, USS JIMMY CARTER (SSN 23), has the same capabilities as her sister ships, plus a unique, 100-foot multimission platform (MMP). The MMP provides unprecedented payload access to the ocean, offering more flexibility and capability than conventional torpedo or vertical launch tubes in the shape or size of weapons, auxiliary vehicles, and sensors.

USS SEAWOLF (SSN 21)

USS SEAWOLF (SSN 21) DATA
(SEAWOLF class)

Length — 353 feet (453 feet for SSN 23)

Beam — 40 feet

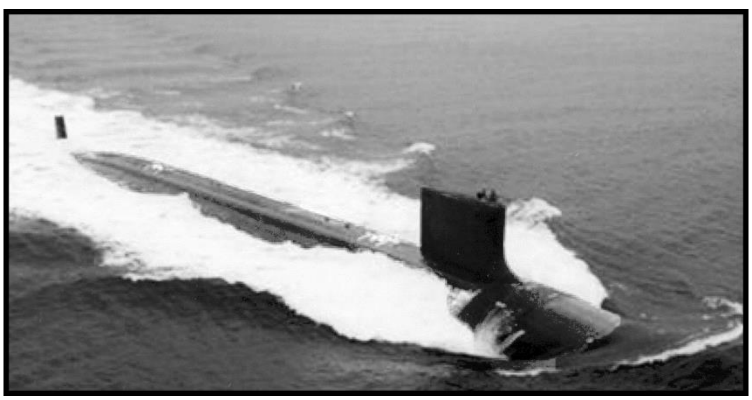
Displacement — Surfaced: 7,460 tons (10,860 tons for SSN 23)
Submerged: 9,150 tons (12,150 tons for SSN 23)

VIRGINIA's multimission capability is in high demand by the combatant commanders, is key to our Undersea Superiority Joint Integrating Concept, and will greatly influence ongoing capabilities-based assessments.

— General Richard B. Myers, USAF
Chairman, Joint Chiefs of Staff
September 2004

USS VIRGINIA (SSN 774) class: USS VIRGINIA, the lead ship of this planned 30-ship class, was commissioned on October 23, 2004 — meeting the schedule established by the original Acquisition Program Baseline over a decade before. The twelfth submarine, USS JOHN WARNER (SSN 785), was commissioned in August 2015. Four more VIRGINIA-class submarines are also under construction. In April 2014, the Navy awarded the largest submarine construction contract in history for ten more VIRGINIA-class submarines (SSN 792 to SSN 801) to General Dynamics Electric Boat and Huntington Ingalls Industries – Newport News Shipbuilding. These ships began construction in 2014 and will be delivered to the Navy between 2019 and 2023.

The VIRGINIA class is designed to excel in near-land ("littoral") operations while maintaining the Navy's superiority in open-ocean operations. By applying the technology developed for the SEAWOLF program, the VIRGINIA class is as quiet and stealthy as the SEAWOLF class. The VIRGINIA class has a reconfigurable torpedo room that can be optimized for a variety of missions, including antisubmarine warfare, *Tomahawk* missile strikes, and special forces delivery. Technological advances have allowed significant improvements in mine detection and avoidance, sensors and surveillance, and communications.



USS HAWAII (SSN 776) on sea trials preceding her early delivery

USS VIRGINIA (SSN 774) DATA
(VIRGINIA class)

Length — 377 feet

Beam — 34 feet

Displacement — Surfaced: 6,970 tons
Submerged: 7,800 tons

The First Aircraft Carrier Prototype: Built at the National Reactor Testing Station in southeastern Idaho, the A1W prototype plant consisted of two reactors and associated steam plant equipment necessary to drive one shaft of an aircraft carrier. On September 15, 1959, A1W first operated at full power. The A1W prototype plant was permanently shut down on January 26, 1994, after more than 34 years of safe operation. Over 14,500 Navy officers and enlisted operators trained at A1W.

USS ENTERPRISE (CVN 65)

USS ENTERPRISE (CVN 65) DATA

Length — 1,123 feet

Overall Width — 257 feet

Combat Load Displacement — 93,000 tons

USS ENTERPRISE (CVN 65): The world's first nuclear-powered aircraft carrier put to sea in 1961 with eight reactors capable of propelling her at speeds in excess of 30 knots. The original cores lasted 3 years; the final ENTERPRISE cores had a life of nearly 20 years. ENTERPRISE is as tall as a 23-story building (keel to mast top), has 4½ acres of flight deck, and carried a crew (including her air wing) of over 5,000. The USS ENTERPRISE was inactivated on December 1, 2012 after 50 years of decorated Naval service and safely steaming more than 1 million miles.

USS ABRAHAM LINCOLN (CVN 72) northbound in the Arabian Sea

USS ABRAHAM LINCOLN (CVN 72) DATA
(NIMITZ class)

Length — 1,092 feet

Overall Width — 257 feet

Combat Load Displacement — 97,500 tons

USS NIMITZ (CVN 68) class: The success of ENTERPRISE led to the larger NIMITZ class. NIMITZ-class aircraft carriers' two reactors produce more power than ENTERPRISE's eight. With larger displacement made possible by a wider hull, she can store 50 percent more ammunition, carry almost twice as much aviation fuel as a conventionally-powered aircraft carrier, and go more than 20 years without refueling, thereby requiring only one refueling in the life of the ship. NIMITZ-class aircraft carriers are over 18 stories tall, have 4½ acres of flight deck, and carry crews (including the air wings) of over 5,500.

An artist's conception of PCU GERALD R. FORD (CVN 78)

PCU GERALD R. FORD (CVN 78) DATA
(GERALD R. FORD class)

Length — 1,092 feet

Overall Width — 256 feet

Combat Load Displacement — 99,500 tons

PCU GERALD R. FORD (CVN 78) class: PCU GERALD R. FORD is the lead ship of the newest class of aircraft carriers. The construction contract was awarded in 2008 and delivery is scheduled for 2016. Taking advantage of the efficiencies of the NIMITZ-class hull form, this new carrier will feature an array of futuristic technologies designed to improve upon the capabilities of the NIMITZ class and, at the same time, allow significant manpower, maintenance, and cost reductions. GERALD R. FORD will be a large-deck nuclear-powered aircraft carrier that maintains the core capabilities of naval aviation while improving affordability of the carrier force. The carrier's design incorporates flexibility into the platform to accommodate future systems and technologies throughout her expected 50-year service life.

Cruisers

Beginning with the 17,000-ton USS LONG BEACH (CGN 9) and the 9,600-ton USS BAINBRIDGE (CGN 25), the Navy built several types of nuclear-powered cruisers. Nuclear power and multimission capability (antiair, antisurface, and antisubmarine) made these cruisers some of the most versatile ships afloat and an effective component of the Navy's Cold War force. Having served proudly, nuclear-powered cruisers have been decommissioned as part of the post–Cold War downsizing of the Fleet.

USS SOUTH CAROLINA (CGN 37) underway in the Indian Ocean

USS SOUTH CAROLINA (CGN 37) DATA
(CALIFORNIA class)

Length — 596 feet

Beam — 61 feet

Displacement — 11,320 tons

Operations

Today, U.S. Navy ships and their dedicated crews are forward-deployed around the globe, protecting the interests of the U.S. and its allies. Their forward presence gives the Nation the cornerstone on which to build peacetime engagement, deterrence and crisis prevention, and conflict resolution. Sustaining and effectively using this forward presence requires agility, mobility, flexibility, and technology. Time and again, nuclear power proves itself as the powerplant technology for fast response, self-sufficiency, and endurance.

Specific details of most naval nuclear-powered warship operations are classified. They cover a wide variety of activities, including thousands of ballistic missile submarine deterrent patrols, offensive and defensive exercises with other U.S. Navy and Allied units, intelligence gathering, amphibious support, escort service, special forces support, and task force deployments to trouble spots around the world. The following examples are a matter of public record, and illustrate the versatility and the endurance of nuclear-powered warships.

In August 1990, Iraq invaded Kuwait, resulting in an unprecedented military buildup in the Persian Gulf region to support Operation ***Desert Shield***. Within days of the Iraqi invasion, the USS DWIGHT D. EISENHOWER (CVN 69) battle group transited the Suez Canal from the Mediterranean to the Red Sea, representing some of the first U.S. military assets to arrive on scene. Over a dozen U.S. attack submarines conducted surveillance, reconnaissance, and other missions before and during the hostilities. As ***Desert Shield*** became ***Desert Storm***, at least two submarines and two nuclear-powered cruisers launched *Tomahawk* cruise missiles against Iraq, and warplanes from USS THEODORE ROOSEVELT (CVN 71) participated in the air attack on Iraq.

USS GEORGE H. W. BUSH (CVN 77) transiting the Suez Canal

As tensions in the Persian Gulf fluctuated throughout the 1990s, aircraft carriers and submarines responded to add strength to our diplomacy and monitor military activities.

The Global War on Terrorism has again showcased the speed, independence from refueling supply chains, and on-station endurance of America's nuclear-powered warships. On September 11, 2001, USS ENTERPRISE was headed home from a 6-month deployment when her Commanding Officer learned of the terrorist attacks on the U.S. via satellite TV. In anticipation of orders to do so, ENTERPRISE executed a right full rudder and was within striking distance of Afghanistan in just under 11 hours. USS GEORGE WASHINGTON (CVN 73) and USS JOHN C. STENNIS (CVN 74) quickly led battle groups to provide protection for both coasts of America. The USS CARL VINSON (CVN 70) and USS THEODORE ROOSEVELT (CVN 71) aircraft carrier battle groups helped take the fight to the enemy, with nuclear-powered attack submarines assisting. Over the first several months of Operation ***Enduring Freedom***, over 70 percent of all precision strike missions flown into landlocked Afghanistan were launched from Navy CVNs, and about a third of all *Tomahawk* precision missile strikes were launched from nuclear-powered submarines.

USS NIMITZ (CVN 68), Guided Missile Cruiser USS PORT ROYAL (CG 73), and USS ANNAPOLIS (SSN 760) in the North Persian Gulf

On March 19, 2003, USS CHEYENNE (SSN 773) began the second chapter in the Global War on Terrorism, Operation ***Iraqi Freedom***, by launching *Tomahawk* missiles against the regime of Saddam Hussein. When over 70 percent of the Fleet surged to the theater, they arrived to a well-prepared battlespace based on intelligence and surveillance gathered by submarines, such as USS PITTSBURGH (SSN 720), and others that had been on-station weeks and months before the first missiles were fired. At the end of major combat operations, nuclear-powered submarines accounted for about a third of the more than 800 *Tomahawk* missiles launched against Saddam Hussein's regime, and nearly 8,000 combat and support sorties had been flown from CVNs.

USS ABRAHAM LINCOLN (CVN 72) exemplified the endurance provided by nuclear propulsion with her 290-day deployment in support of Operations ***Enduring Freedom***, ***Southern Watch***, and ***Iraqi Freedom***, in which she steamed over 100,000 miles on nuclear power. Her nearly 10-month deployment was the longest aircraft carrier deployment in 30 years. Today, nuclear-powered warships continue to bring their unique mix of capabilities to the Global War on Terrorism.

The versatility of NIMITZ-class CVNs is continuously demonstrated during humanitarian assistance and disaster relief operations. Once on-station, carriers provide much needed supplies, including pure drinking water produced by nuclear power. USS ABRAHAM LINCOLN responded rapidly to the tsunami crisis of December 2004 and USS HARRY S TRUMAN (CVN 75) provided humanitarian assistance to the Gulf Coast after the devastation wrought by Hurricane Katrina. USS CARL VINSON was immediately dispatched to assist the people of Haiti following a devastating earthquake in 2010. In March 2011, USS RONALD REAGAN provided disaster relief to Japan in support of Operation ***Tomodachi***, following a devastating earthquake and tsunami that struck the island of Honshu. USS GEORGE WASHINGTON provided similar rapid assistance to the people of the Philippines following Typhoon Haiyan in November 2013.

USS ABRAHAM LINCOLN (CVN 72) and USNS MERCY (T-AH 19)

At the end of 2008, USS OHIO (SSGN 726) returned to Naval Base Kitsap-Bangor after her first deployment as an SSGN. During her 14 months away from home, she successfully completed three national taskings, earned two Navy Expeditionary medals, and hosted a Joint Special Operations Task Force while visiting Busan, Republic of Korea to demonstrate the joint command and control capability of the new SSGN platform.

In late March 2011, USS FLORIDA (SSGN 728) and her crew demonstrated the strike capabilities of the SSGN fleet by launching 93 tomahawk missiles in support of Operation ***Odyssey Dawn***. FLORIDA launched more than one-third of the initial salvo on the first night as the Joint Force commenced ***Odyssey Dawn*** to enforce U.N. resolutions against the Libyan Dictator Moammar Gadhafi. Nearly a year into her deployment, FLORIDA was still able to take center stage in the operation.

> We marvel at the unparalleled stealth, speed, and endurance of our Nation's submarine force. These ships, along with nuclear-powered aircraft carriers, provide our Nation with the strategic deterrence, forward presence, and capability for rapid responses to crises. To be sure, the contributions of the nuclear navy to the ongoing Global War on Terror are indisputable.
>
> *— The Honorable Duncan L. Hunter*
> *Chairman, House Armed Services Committee*
> *September 2004*

Arctic Operations

From both a strategic and scientific standpoint, the Arctic Ocean is an important region. Strategically, the Arctic ice can be used as cover to approach the shores of bordering nations, including our own. Scientifically, Arctic ice and water hold information that can be used to better understand the world's ever-changing environment.

At the same time, the Arctic is one of the most challenging environments on the planet; perhaps nowhere else is the tactical flexibility provided by nuclear power more evident than in under-ice operations. A submarine operating under the ice must maneuver carefully, using special sonar equipment to avoid shifting ice packs, and keep track of clearances, not only below the ship, because the Arctic Ocean is quite shallow in many places, but also above the ship, where thick ice extends downward. In addition, under-ice operations prevent submarine crews from relying on navigation satellites (commonly used in open waters to keep track of position), requiring instead the use of shipboard inertial navigation systems and computers which must be constantly updated through calculations based on the movement of the ship. Communication, if necessary in the Arctic, requires a submarine to locate an area of thin ice and then carefully break through to the surface.

USS RAY (SSN 653), USS HAWKBILL (SSN 666), and USS ARCHERFISH (SSN 678) surfaced at the Geographic North Pole, May 6, 1986

The first U.S. submarine Arctic operations were conducted in 1946 when the diesel-powered submarine, USS ATULE (SS 403), conducted a brief excursion under the ice, limited by the need to recharge her batteries. In 1957, USS NAUTILUS (SSN 571) became the first nuclear-powered submarine to operate under the ice, and in 1958 she conducted the first submerged transpolar crossing, reaching the geographic North Pole on August 3, 1958. In 1959, USS SKATE (SSN 578) became the first ship to surface at the North Pole. In subsequent years, many U.S. nuclear-powered submarines have operated under, and surfaced through, the polar ice cap. In 2002, USS CONNECTICUT (SSN 22) became the first SEAWOLF-class submarine to surface from under Arctic ice.

While conducting operations in the Arctic, U.S. submarines often collect data and samples for scientific study. Occasionally, scientists embark on the submarines to carry out more sophisticated tests and experiments. In the spring of 1999, USS HAWKBILL (SSN 666) conducted an extensive mission to the Arctic to support numerous scientific studies and mapping. This mission successfully concluded a series of five Arctic expeditions conducted as a joint venture between the Navy and the National Science Foundation. As these trips under the polar ice demonstrate, nuclear power has significantly augmented our ability to explore the far reaches of our planet.

USS HAMPTON (SSN 767) surfaces at U.S. Navy Ice Camp Nautilus, located on an ice sheet adrift in the Arctic Ocean, as part of ICEX 2014

Special Projects

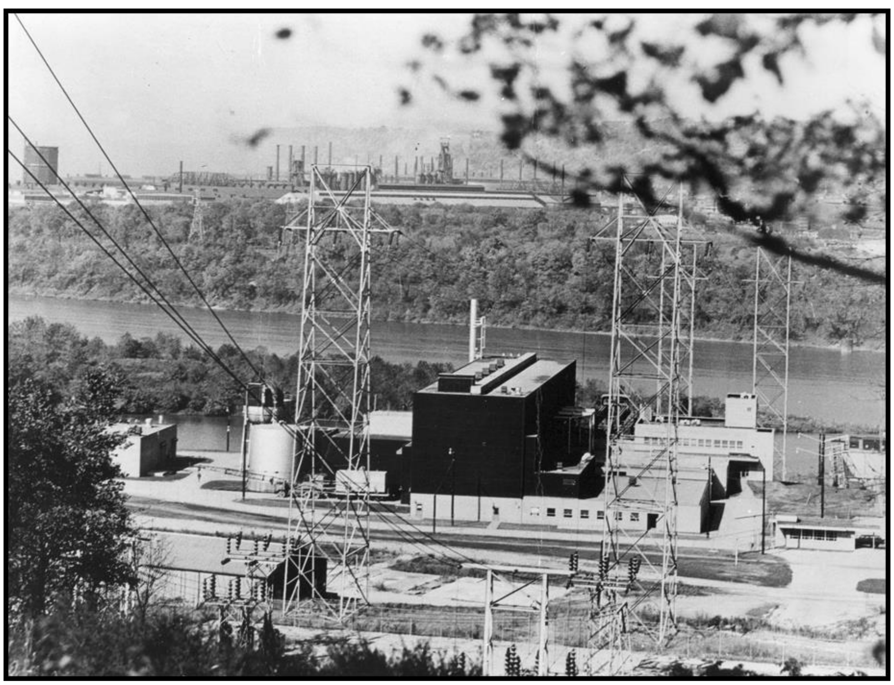
Shippingport

Because of the Program's success with nuclear reactors, President Eisenhower made the Program responsible for developing the Shippingport Atomic Power Station — the world's first full-scale atomic powerplant built solely for the production of electricity. Operated by the Duquesne Light Company, Shippingport's pressurized-water reactor (PWR) design and original cores became prototypes for the majority of commercial nuclear power stations. Other Shippingport achievements include the following:

- Provided power to Duquesne Light Company customers from 1957-1974 with PWR design cores.

- Was available for operation about 65 percent of its life—higher than most other commercial plants at the time — despite numerous planned shutdowns for R&D purposes.

- First safeguards report for a nuclear power station.



Shippingport Atomic Power Station

Light Water Breeder Reactor (LWBR)

In the early 1960s, the AEC focused R&D efforts on liquid-metal breeder reactors that would generate more fissionable material than they would consume while producing power. Conventional wisdom was that breeding would not be possible in a PWR plant. The Program's successful development of an LWBR core at Shippingport dispelled that notion:

- In 1965, LWBR development began with uranium-233 as the "fissile" material; and thorium, the "fertile" material. Successful use of thorium, a plentiful resource, would provide a source of energy many times greater than the known fossil fuel reserves.

- In 1977, the LWBR began operation at Shippingport, generating electricity for Duquesne Light Company for 5 years.

- The LWBR core was very reliable, achieving a level of online operation similar to its PWR predecessor.

- Extensive end-of-life testing confirmed that the LWBR had operated as designed. In fact, breeding occurred at a rate higher than predicted. The performance of the core material was excellent.

- LWBR technical reports were made available to the commercial nuclear power industry.

The Program remained responsible for Shippingport through end-of-life testing and defueling. DOE decommissioned Shippingport in 1989, removed all radioactive components, and returned the site to "green-field" condition.

Shippingport site today

NR-1

In 1965, the Program began development of a nuclear-powered deep-submergence research and ocean engineering vehicle, designated NR-1. The capability of this manned vehicle was far greater than any other research vessel planned or developed at that time because of the vastly increased endurance and independence from surface support made possible by nuclear power. Launched in January 1969 at Electric Boat, Groton, and decommissioned in November 2008, NR-1 provided valuable service to the Navy, other Government agencies, and research and educational institutions. In addition to its small nuclear propulsion plant, which provided virtually limitless submerged endurance, NR-1's characteristics included the following:

- A 400-ton submerged displacement, 150-foot length, and 12-foot diameter.
- A speed of approximately 4 knots, two external electric motors.
- A 3,000-foot operating depth.
- Retractable bottoming wheels.
- Viewing ports and exterior lighting, as well as color television and still cameras for photographic studies.
- An object recovery claw and manipulator with gripping and cutting capability.

NR-1

NR-1 was equipped with sophisticated electronics and computers to aid navigation, communications, and object location and identification. She could maneuver or hold a steady position on or close to the seabed or underwater ridges to detect and identify objects at a considerable distance and to lift objects off the ocean floor.

NR-1 had a crew of 5-10 specially trained Navy volunteers and 2 scientists. Able to remain submerged and move at maximum speed for extended periods of time, she performed detailed studies and mapping of the ocean bottom (including temperature, currents, and other oceanographic data) for military and scientific uses.

The unique capabilities of NR-1 put her in high demand in both the military and the scientific communities. NR-1 could remain submerged for up to a month, allowing her to survey large areas even in inclement weather. The following are a few of NR-1's past scientific missions:

- Participating in the search, identification, and recovery of critical parts of the space shuttle *Challenger* and Egypt Air Flight 990 wreckages.

- Exploring the wreckage of HMHS *Britannic* (RMS *Titanic*'s sister ship), lost in the Mediterranean during World War II under mysterious circumstances.

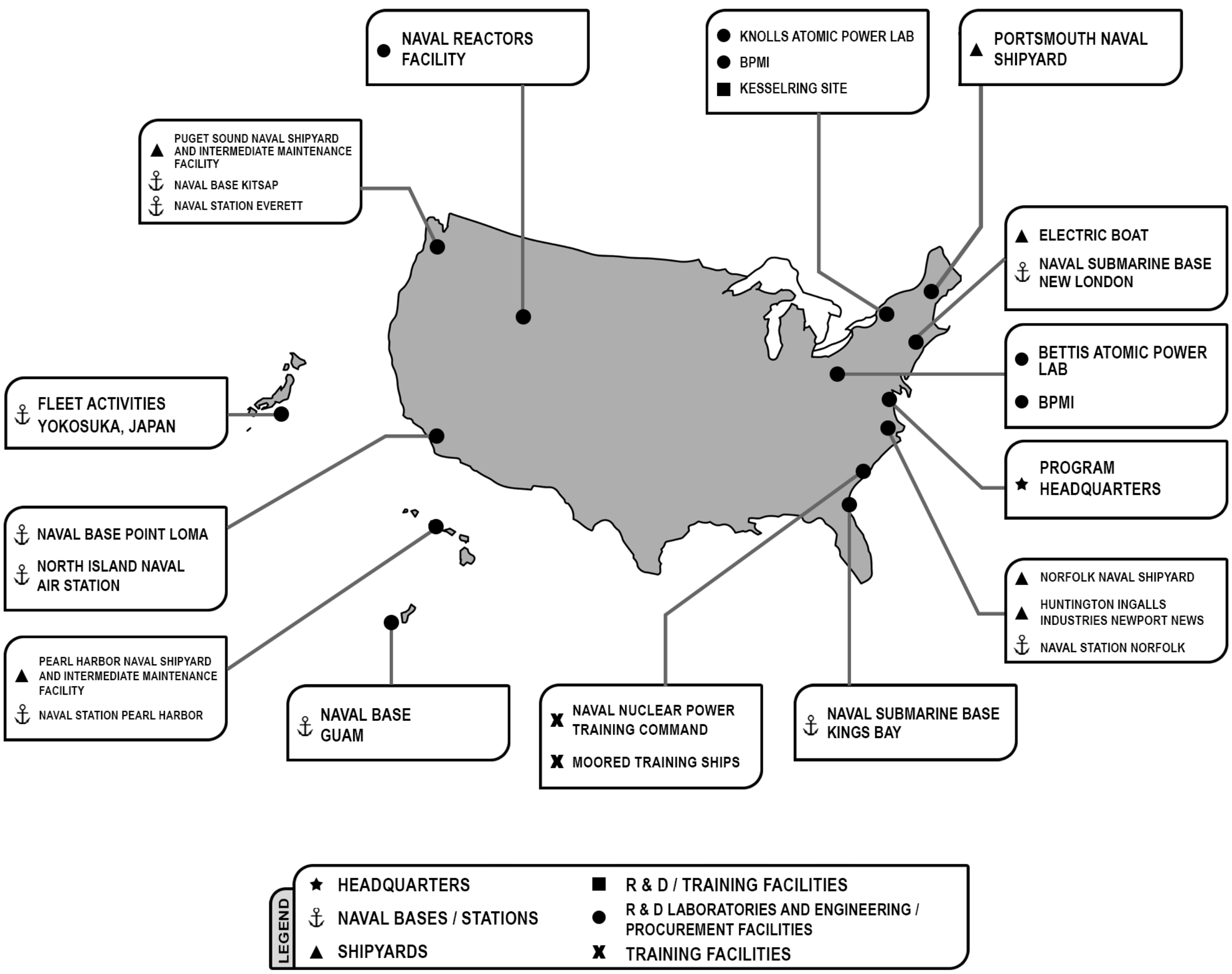
- Locating and surveying ancient Roman shipwrecks lost while on trading voyages between Rome and Carthage.

- Participating in Jason Project VII, a joint scientific and educational effort with an overall mission of engaging students in science and technology through the use of interactive telecommunications.

NR-1 with her support vessel SSV CAROLYN CHOUEST off Key Largo, Florida

Program Locations

As seen on the map below, Naval Nuclear Propulsion Program activities can be found throughout the United States. From the Portsmouth Naval Shipyard at Kittery, Maine, to the submarine base at Pearl Harbor, Hawaii; from the training center at Charleston, South Carolina, to the *Trident* base at Bangor, Washington, Program interests crisscross the Nation. With submarines based in Guam, an aircraft carrier forward deployed in Yokosuka, Japan, and U.S. nuclear-powered vessels welcome in numerous ports throughout the world, the Naval Nuclear Propulsion Program is truly global in scope.



Program Directors – Past and Present

Admiral Hyman G. Rickover
U.S. Navy

DIRECTOR
AUGUST 4, 1948 – JANUARY 31, 1982

Admiral Hyman G. Rickover, the Father of the Nuclear Navy, was born in Makow, Russia, on January 27, 1900. At the age of 6, he came to the United States, settling in Chicago, Illinois. Admiral Rickover entered the U.S. Naval Academy in 1918 and was commissioned an ensign in June 1922.

Following sea duty aboard the destroyer USS LA VALLETTE (DD 315) and the battleship USS NEVADA (BB 36), Admiral Rickover attended Columbia University, where he earned the degree of Master of Science in Electrical Engineering. From 1929 to 1933, he qualified for submarine duty and command aboard the submarines USS S 9 (SS 114) and USS S 48 (SS 159). In June 1937, he assumed command of the minesweeper USS FINCH (AM 9). Later that year, he was selected as an Engineering Duty Officer and spent the remainder of his career serving in that specialty.

During World War II, Admiral Rickover served as Head of the Electrical Section of the Bureau of Ships and later as Commanding Officer of the Naval Repair Base, Okinawa. In 1946, he was assigned to the U.S. Atomic Energy Commission (AEC) Laboratory at Oak Ridge, Tennessee, and, in early 1949, to the Division of Reactor Development, AEC.

As director of the Naval Reactors Branch, Admiral Rickover developed the world's first nuclear-powered submarine, USS NAUTILUS (SSN 571), which went to sea in 1955. In the years that followed, Admiral Rickover directed all aspects of building and operating the nuclear fleet.

Admiral Rickover's numerous medals and decorations include the Distinguished Service Medal, Legion of Merit, Navy Commendation Medal, and the World War II Victory Medal. In recognition of his wartime service, he was made Honorary Commander of the Military Division of the Most Excellent Order of the British Empire. Admiral Rickover was twice awarded the Congressional Gold Medal for exceptional public service. In 1980, President Jimmy Carter presented Admiral Rickover with the Presidential Medal of Freedom, the Nation's highest non-military honor, for his contributions to world peace.

Admiral Rickover retired from the United States Navy on January 31, 1982, after over 63 years of service to his country and to 13 Presidents. His name was memorialized in the attack submarine USS HYMAN G. RICKOVER (SSN 709) and Rickover Hall at the Naval Academy. Admiral Rickover died on July 8, 1986, and is buried at Arlington National Cemetery. The Engineering Honor Society Tau Beta Pi named Admiral Rickover as one of the Top Ten Engineers of the Twentieth Century in December 1999.

Admiral Kinnaird R. McKee
U.S. Navy

DIRECTOR
FEBRUARY 1, 1982 – OCTOBER 21, 1988

Admiral Kinnaird R. McKee was born in Louisville, Kentucky, on August 14, 1929, and graduated from the U.S. Naval Academy in 1951. He served aboard the Pacific fleet destroyer USS MARSHALL (DD 676) during the Korean War and in eight submarines of the Atlantic fleet since that time. After completion of submarine training in 1953, he served in three diesel-powered submarines: USS PICUDA (SS 382), USS SEA CAT (SS 399), and USS MARLIN (SST 2). In 1956, Admiral McKee was ordered to command of USS X-1, a small experimental submarine. He graduated from nuclear power training in 1958 and joined the commissioning crew of USS SKIPJACK (SSN 585), the Navy's first high-performance nuclear-powered attack submarine. Assignment as Executive Officer, USS NAUTILUS (SSN 571), followed in 1961; then of USS SAM HOUSTON (SSBN 609) in late 1962. After three deterrent patrols in SAM HOUSTON, he served in the Naval Reactors Division of the U.S. Atomic Energy Commission from 1964 to 1966.

Admiral McKee served as Commanding Officer of the nuclear-powered attack submarine USS DACE (SSN 607) from 1966 through 1969. The ship was twice awarded the Navy Unit Commendation and three times the Battle Efficiency Pennant for operations during that period. Following command of DACE, Admiral McKee served in the office of the Director, Navy Program Planning, where his responsibilities included strategic warfare, research and development, and submarine and antisubmarine warfare systems. In 1970, he was assigned to the immediate staff of the Chief of Naval Operations, where he established the CNO Executive Panel. As Commander, Submarine Group EIGHT, Admiral McKee served as the NATO and U.S. Submarine Commander in the Mediterranean from 1973 to 1975. On August 1, 1975, he became the 48th Superintendent of the U.S. Naval Academy. Promoted to three-star rank in March 1978, Admiral McKee served as Commander, THIRD Fleet with headquarters in Pearl Harbor. He was then assigned as Director, Naval Warfare, Office of the Chief of Naval Operations, concurrent with the expansion of the directorate from its original concentration on antisubmarine warfare to responsibility for all aspects of naval warfare. He developed and implemented the new organization.

On February 1, 1982, he relieved Admiral H. G. Rickover as Director, Naval Nuclear Propulsion. On March 2, 1982, he was confirmed by the U.S. Senate for promotion to four-star rank.

Admiral McKee's decorations include the Distinguished Service Medal, five awards of the Legion of Merit, and three awards of the Navy Unit Commendation.

Admiral McKee retired on October 31, 1988, after 41 years of service to his country.

Admiral McKee died on December 30, 2013, and is buried at the U. S. Naval Academy Cemetery.

Admiral Bruce DeMars
U.S. Navy

DIRECTOR
OCTOBER 22, 1988 – SEPTEMBER 26, 1996

Admiral Bruce DeMars was born in Chicago, Illinois, on June 3, 1935, and graduated from the U.S. Naval Academy in 1957. Following commissioning, he served in the attack transports USS TELFAIR (APA 210) and USS OKANOGAN (APA 220) and, after Submarine School, the diesel-electric submarine USS CAPITAINE (SS 336). Following nuclear power training, he served in the nuclear-powered submarines USS GEORGE WASHINGTON (SSBN 598), USS SNOOK (SSN 592), and USS STURGEON (SSN 637) before reporting for duty as Commanding Officer, USS CAVALLA (SSN 684).

Shore duty tours included instructor duty at Nuclear Power School and Submarine School and attendance at the Armed Forces Staff College. After staff duty with Submarine Squadron TEN, Admiral DeMars served as Senior Member of the Nuclear Propulsion Examining Board, U.S. Atlantic Fleet. He commanded Submarine Development Squadron TWELVE in New London, Connecticut and then served as Deputy Director, Attack Submarine Division in the Office of the Chief of Naval Operations, until selected for promotion to Rear Admiral in 1981.

As a Flag Officer, Admiral DeMars served as Commander, U.S. Naval Forces Marianas/ Commander, U.S. Naval Base Guam; as Commander in Chief, Pacific Representative for Guam and the Trust Territory of the Pacific Islands; and as Deputy Assistant Chief and then Deputy Chief of Naval Operations for Submarine Warfare.

On September 30, 1988, he was confirmed by the U.S. Senate for promotion to four-star rank. On October 22, 1988, he relieved Admiral McKee as Director, Naval Nuclear Propulsion.

Admiral DeMars retired on October 1, 1996, after 43 years of service to his country.

Admiral DeMars's decorations include the Distinguished Service Medal, four awards of the Legion of Merit, two awards of the Meritorious Service Medal, two awards of the Navy Commendation Medal, the Navy Achievement Medal, and the Navy Unit Commendation.

Admiral Frank L. "Skip" Bowman
U.S. Navy

DIRECTOR
SEPTEMBER 27, 1996 – NOVEMBER 4, 2004

Admiral Frank L. "Skip" Bowman was born and grew up in Chattanooga, Tennessee. He was commissioned following graduation from Duke University. In 1973, he completed a dual master's program in nuclear engineering and naval architecture / marine engineering at the Massachusetts Institute of Technology and was elected to the Society of Sigma Xi. He has served on two visiting committees at MIT (Ocean Engineering and Nuclear Engineering), the Engineering Board of Visitors at Duke University, and the Nuclear Engineering Department Advisory Committee at the University of Tennessee.

His early assignments included tours in USS SIMON BOLIVAR (SSBN 641), USS POGY (SSN 647), USS DANIEL BOONE (SSBN 629), and USS BREMERTON (SSN 698). In 1983, Admiral Bowman took command of USS CITY OF CORPUS CHRISTI (SSN 705), which completed a 7-month circumnavigation of the globe and two special classified missions during his command tour. His crew earned three consecutive Battle Efficiency "E" awards. Admiral Bowman later commanded the tender USS HOLLAND (AS 32) from August 1988 to April 1990. During this period, the HOLLAND crew was awarded two Battle Efficiency "E" awards.

Ashore, Admiral Bowman has served on the staff of Commander, Submarine Squadron FIFTEEN, in Guam; twice in the Bureau of Naval Personnel in the Submarine Policy and Assignment Division; as the SSN 21 Attack Submarine Program Coordinator on the staff of the Chief of Naval Operations; on the Chief of Naval Operations' Strategic Studies Group; and as Executive Assistant to the Deputy Chief of Naval Operations (Naval Warfare). In December 1991, he was promoted to flag rank and assigned as Deputy Director of Operations on the Joint Staff (J-3) until June 1992, and then as Director for Political-Military Affairs (J-5) until July 1994. Admiral Bowman served as Chief of Naval Personnel from July 1994 to September 1996.

Admiral Bowman assumed duties as Director, Naval Nuclear Propulsion, on September 27, 1996, and was promoted to the four-star rank on October 1, 1996.

Admiral Bowman retired on January 1, 2005, after more than 38 years of service.

Under his command, his crews have earned the Meritorious Unit Commendation (three awards), the Navy Battle Efficiency "E" Ribbon (five awards), the Navy Expeditionary Medal (two awards), the Humanitarian Service Medal (two awards), the Sea Service Deployment Ribbon (three awards), and the Navy Arctic Service Ribbon. His personal awards include the Defense Distinguished Service Medal, the Navy Distinguished Service Medal, the Legion of Merit (with three gold stars), and the *Officier de l'Ordre National du Mérite* from the Government of France.

Admiral Kirkland H. Donald
U.S. Navy

DIRECTOR
NOVEMBER 5, 2004 – NOVEMBER 2, 2012

Originally from Norlina, North Carolina, Admiral Kirkland H. Donald graduated from the U.S. Naval Academy in 1975 with a bachelor of science in ocean engineering. He also holds a master's degree in business administration from the University of Phoenix and is a graduate of Harvard University's John F. Kennedy School of Government Senior Executive Fellows Program.

After nuclear power and submarine training, he served in USS BATFISH (SSN 681), USS MARIANO G. VALLEJO (SSBN 658), and USS SEAHORSE (SSN 669).

Admiral Donald was Commanding Officer, USS KEY WEST (SSN 722), from October 1990 to February 1993. He served as Commander, Submarine Development Squadron TWELVE from August 1995 to July 1997. From June 2002 to July 2003, he was assigned as Commander, Submarine Group EIGHT; Commander, Submarine Force SIXTH Fleet (CTF 69); Commander, Submarines Allied Naval Forces South; and Commander, Fleet Ballistic Missile Submarine Force (CTF 164) in Naples, Italy. Most recently, he served as Commander, Naval Submarine Forces; Commander, Submarine Force, U.S. Atlantic Fleet; Commander, Allied Submarine Command; and Commander, Task Forces 84 and 144, in Norfolk, Virginia.

His shore assignments include the Pacific Fleet Nuclear Propulsion Examining Board and the staff of the Director, Naval Nuclear Propulsion. He also served at the Bureau of Naval Personnel, on the Joint Staff, and as Deputy Chief of Staff for C4I, Resources, Requirements and Assessments, U.S. Pacific Fleet.

Admiral Donald was confirmed by the Senate to receive a fourth star on September 30, 2004 and assumed duties as Director, Naval Nuclear Propulsion, on November 5, 2004. Admiral Donald retired in December 2012 after more than 37 years of service.

Admiral Donald is authorized to wear the Navy Distinguished Service Medal (three awards), Defense Superior Service Medal, Legion of Merit with four gold stars, and the Meritorious Service Medal with one gold star, in addition to other personal and unit awards.

Admiral John M. Richardson
U.S. Navy

DIRECTOR
NOVEMBER 2, 2012 – AUGUST 14, 2015

Admiral Richardson graduated from the U. S. Naval Academy in 1982 with a Bachelor of Science in Physics. He also holds Masters Degrees from the Massachusetts Institute of Technology and the Woods Hole Oceano-graphic Institution, and the National War College.

Admiral Richardson served in USS PARCHE (SSN 683), USS GEORGE C. MARSHALL (SSBN 654) and USS SALT LAKE CITY (SSN 716). He commanded USS HONOLULU (SSN 718) in Pearl Harbor, Hawaii and was awarded the James Bond Stockdale Leadership Award.

Admiral Richardson served as Commodore of Submarine Development Squadron 12 in Groton, Connecticut; Commander, Submarine Group 8; Commander, Submarine Allied Naval Forces South; Deputy Commander, U. S. 6th Fleet; Chief of Staff, U. S. Naval Forces Europe and U. S. Naval Forces Africa, in Naples Italy; and Commander, Naval Submarine Forces in Norfolk, Virginia.

Admiral Richardson's staff assignments include duty in the Attack Submarine Division on the Chief of Naval Operations staff; Naval Aide to the President; prospective commanding officer instructor for Commander, Submarine Forces, U. S. Pacific Fleet; Assistant Deputy Director for Regional Operations on the Joint Staff; and Director of Strategy and Policy at U. S. Joint Forces Command.

Admiral Richardson served on teams that have been awarded the Presidential Unit Citation, the Joint Meritorious Unit Citation, the Navy Unit Citation, and the Battle Efficiency E Awards.

Admiral Richardson assumed duties as Director, Naval Nuclear Propulsion, on November 2, 2012. On August 5, 2015, Admiral Richardson was confirmed as the 31st Chief of Naval Operations by the U.S. Senate, turning over duties as Director, Naval Nuclear Propulsion, on August 14, 2015.

Admiral Richardson began serving as the Chief of Naval Operations on September 18, 2015.

Admiral James F. Caldwell, Jr.
U.S. Navy

DIRECTOR
AUGUST 14, 2015 – PRESENT

Admiral Caldwell received his commission graduating with distinction from the U. S. Naval Academy in 1981 with a Bachelor of Science in Marine Engineering. He also holds Master of Science in Operations Research from the Naval Postgraduate School.

Admiral Caldwell commanded USS JACKSONVILLE (SSN 699) homeported in Norfolk, Virginia; Submarine Development Squadron (DEVRON) 12 in New London, Connecticut; Submarine Group 9 in Bangor, Washington; and the Submarine Force, U.S. Pacific Fleet in Hawaii. His sea tours include service in both the Atlantic and Pacific Fleets. His operational assignments include duty as division officer on USS BOSTON (SSN 703), engineer officer on USS ALABAMA (SSBN 731) (GOLD), and executive officer on USS BUFFALO (SSN 715).

Ashore, Admiral Caldwell served on the Pacific Fleet Nuclear Propulsion Examining Board and later as Undersea Warfare (USW) Requirements officer on the staff of Commander in Chief, U.S. Pacific Fleet. He also served as senior member of the Naval Submarine Force's Tactical Readiness Evaluation Team, and on the Joint Staff as deputy director for Politico-Military Affairs for Europe, the North Atlantic Treaty Organization, Russia and Africa. His flag tours ashore include deputy commander for U.S. Strategic Command's Joint Functional Component Command for Global Strike in Omaha, Nebraska; the Naval Inspector General, Washington Navy Yard, D.C.; and most recently on the (Office of Naval Operations) OPNAV Staff as the Director, Navy Staff.

Admiral Caldwell assumed his current duties as Director, Naval Nuclear Propulsion, on August 14, 2015.

Admiral Caldwell's awards include the Distinguished Service Medal, Defense Superior Service Medal, Legion of Merit, Meritorious Service Medal, Navy Commendation Medal, Navy and Marine Corps Achievement Medal, and the Naval Submarine League's Charles A. Lockwood Award.

Program Statistics

(As of November 2015)

Active nuclear-powered combat submarines	73
Active nuclear-powered aircraft carriers	10
TOTAL ACTIVE NUCLEAR-POWERED SHIPS	**83**
Total nuclear-powered ships built	225
Number of miles steamed on nuclear power	>157,000,000
Number of reactor-years of operation	>6,700
Number of officers trained or in training	>23,000
Number of enlisted personnel trained or in training	>109,000
Number of civilians trained or in training	>2,000
Total number of cores taken critical (including refuelings)	538
Number of reactors currently in operation	96
Percentage of major Navy combatants that are nuclear-powered	>45%

A LOS ANGELES-class attack submarine surfacing

U.S. Nuclear-Powered Ship Program Summary

Class	*Authorized by Congress*	*Under Construction*	*In Commission*	*Decommissioned*
VIRGINIA (SSN 774)	28	10	12	0
SEAWOLF (SSN 21)	3	0	3	0
LOS ANGELES (SSN 688)	62	0	40	22
Other SSNs (Fast Attack Subs)	68 [1]	0	0	78 [1]
TOTAL SSNs	*161*	*10*	*55*	*100*
USS OHIO (SSGN 726) – *Trident*	18	0	14 [2]	0
Polaris / Poseidon SSBNs (Ballistic Missile Subs)	41 [1]	0	0	31 [1]
TOTAL SSBNs	*59*	*0*	*14*	*31*
TOTAL SSGNs	0	0	4 [2]	0
TOTAL SUBMARINES	*220*	*10*	*73*	*131*
CVNs (Nuclear-Powered Aircraft Carriers)	13	2	10	1 [3]
CGNs (Nuclear-Powered Guided Missile Cruisers)	9	0	0	9
TOTAL NUCLEAR-POWERED SURFACE SHIPS	*22*	*2*	*10*	*10*
TOTAL NUCLEAR-POWERED SHIPS	*242*	*12*	*83*	*141*

1 Ten ships originally authorized by Congress as a fleet ballistic missile submarines were converted to fast-attack submarines.
2 Four SSBNs were removed from strategic service and designated SSGNs.
3 USS ENTERPRISE was inactivated in December 2012. Decommissioning will not be complete until after the reactors are defueled.

U.S. Nuclear-Powered Submarines

NUCLEAR-POWERED ATTACK SUBMARINES (SSN)

Name	*Hull Nr.*	*Class*	*Builder*	*Shpbldg Prog. FY*	*Keel Laid*	*Launched*	*Comm'd*	*Decomm'd*
Nautilus	SSN 571	571	Electric Boat	1952	06/14/52	01/21/54	09/30/54	03/03/80
Seawolf	SSN 575	575	Electric Boat	1953	09/07/53	07/21/55	03/30/57	03/31/87
Skate	SSN 578	578	Electric Boat	1955	07/21/55	05/16/57	12/23/57	09/12/86
Swordfish	SSN 579	578	Portsmouth	1955	01/25/56	08/27/57	09/15/58	06/02/89
Sargo	SSN 583	578	Mare Island	1956	02/21/56	10/10/57	10/01/58	02/26/88
Seadragon	SSN 584	578	Portsmouth	1956	06/20/56	08/16/58	12/05/59	06/12/84
Skipjack	SSN 585	585	Electric Boat	1956	05/29/56	05/26/58	04/15/59	04/19/90
Triton	SSN 586	586	Electric Boat	1956	05/29/56	08/19/58	11/10/59	04/30/86
Halibut	SSN 587	587	Mare Island	1956	04/11/57	01/09/59	01/04/60	06/30/76
Scamp	SSN 588	585	Mare Island	1957	01/23/59	10/08/60	06/05/61	04/28/88
Scorpion	SSN 589	585	Electric Boat	1957	08/20/58	12/19/59	07/29/60	05/22/68 [1]
Sculpin	SSN 590	585	Ingalls	1957	02/03/58	03/31/60	06/01/61	08/03/90
Shark	SSN 591	585	Newport News	1957	02/24/58	03/16/60	02/09/61	09/15/90
Snook	SSN 592	585	Ingalls	1957	04/07/58	10/31/60	10/24/61	10/16/86
Permit	SSN 594	594	Mare Island	1958	05/01/59	07/01/61	05/29/62	07/23/91
Thresher	SSN 593	594	Portsmouth	1957	05/28/58	07/09/60	08/03/61	04/10/63 [1]
Plunger	SSN 595	594	Mare Island	1958	03/02/60	12/09/61	11/21/62	02/02/90
Barb	SSN 596	594	Ingalls	1958	11/09/59	02/12/62	08/24/63	12/20/89
Pollack	SSN 603	594	NY Shipbuilding	1959	03/14/60	03/17/62	05/26/64	03/01/89
Haddo	SSN 604	594	NY Shipbuilding	1959	09/09/60	08/18/62	12/16/64	06/12/91
Jack	SSN 605	594	Portsmouth	1959	09/16/60	04/24/63	03/31/67	07/11/90
Tinosa	SSN 606	594	Portsmouth	1959	11/24/59	12/09/61	11/17/64	01/15/92
Dace	SSN 607	594	Ingalls	1959	06/06/60	08/18/62	04/04/64	12/02/88
Guardfish	SSN 612	594	NY Shipbuilding	1960	02/28/61	05/15/65	12/20/66	02/04/92
Flasher	SSN 613	594	Electric Boat	1960	04/14/61	06/22/63	07/22/66	09/14/92
Greenling	SSN 614	594	Quincy	1960	08/15/61	04/04/64	11/03/67	04/18/94
Gato	SSN 615	594	Quincy	1960	12/15/61	05/14/64	01/25/68	04/25/96
Haddock	SSN 621	594	Ingalls	1961	04/24/61	05/21/66	12/22/67	04/07/93
Tullibee	SSN 597	597	Electric Boat	1958	05/26/58	04/27/60	11/09/60	06/18/88
Sturgeon	SSN 637	637	Electric Boat	1962	08/10/63	02/26/66	03/03/67	08/01/94
Whale	SSN 638	637	Quincy	1962	05/27/64	10/14/66	10/12/68	06/25/96
Tautog	SSN 639	637	Ingalls	1962	01/27/64	04/15/67	08/17/68	03/31/97
Grayling	SSN 646	637	Portsmouth	1963	05/12/64	06/22/67	10/11/69	07/18/97
Pogy	SSN 647	637	NY Ship / Ingalls	1963	05/05/64	06/03/67	05/15/71	06/11/99
Aspro	SSN 648	637	Ingalls	1963	11/23/64	11/29/67	02/20/69	03/31/95
Sunfish	SSN 649	637	Quincy	1963	01/15/65	10/14/66	03/15/69	03/31/97
Pargo	SSN 650	637	Electric Boat	1963	06/03/64	09/17/66	01/05/68	04/14/95
Queenfish	SSN 651	637	Newport News	1963	05/11/64	02/25/66	12/06/66	04/14/92
Puffer	SSN 652	637	Ingalls	1963	02/08/65	03/30/68	08/09/69	07/12/96
Ray	SSN 653	637	Newport News	1963	01/04/65	06/21/66	04/12/67	03/16/93
Sand Lance	SSN 660	637	Portsmouth	1964	01/15/65	11/11/69	09/25/71	08/07/98
Lapon	SSN 661	637	Newport News	1964	07/26/65	12/16/66	12/14/67	08/08/92
Gurnard	SSN 662	637	Mare Island	1964	12/22/64	05/20/67	12/06/68	04/28/95
Hammerhead	SSN 663	637	Newport News	1964	11/29/65	04/14/67	06/28/68	04/05/95
Sea Devil	SSN 664	637	Newport News	1964	04/12/66	10/05/67	01/30/69	10/16/91
Guitarro	SSN 665	637	Mare Island	1965	12/09/65	07/27/68	09/09/72	05/29/92
Hawkbill	SSN 666	637	Mare Island	1965	09/12/66	04/12/69	02/04/71	03/15/00
Bergall	SSN 667	637	Electric Boat	1965	04/16/66	02/17/68	06/13/69	06/06/96
Spadefish	SSN 668	637	Newport News	1965	12/21/66	05/15/68	08/14/69	04/11/97
Seahorse	SSN 669	637	Electric Boat	1965	08/13/66	06/15/68	09/19/69	08/17/95
Finback	SSN 670	637	Newport News	1965	06/26/67	12/07/68	02/04/70	03/28/97
Pintado	SSN 672	637	Mare Island	1966	10/27/67	08/16/69	09/11/71	02/26/98
Flying Fish	SSN 673	637	Electric Boat	1966	06/30/67	05/17/69	04/29/70	05/16/96

[1] Lost at sea

Name	*Hull Nr.*	*Class*	*Builder*	*Shpbldg Prog. FY*	*Keel Laid*	*Launched*	*Comm'd*	*Decomm'd*
Trepang	SSN 674	637	Electric Boat	1966	10/28/67	09/27/69	08/14/70	06/01/99
Bluefish	SSN 675	637	Electric Boat	1966	03/13/68	01/10/70	01/08/71	05/31/96
Billfish	SSN 676	637	Electric Boat	1966	09/20/68	05/01/70	03/12/71	07/01/99
Drum	SSN 677	637	Mare Island	1966	08/20/68	05/23/70	04/15/72	10/30/95
Archerfish	SSN 678	637	Electric Boat	1967	06/19/69	01/16/71	12/17/71	03/31/98
Silversides	SSN 679	637	Electric Boat	1967	10/13/69	06/04/71	05/05/72	07/21/94
William H. Bates	SSN 680	637	Ingalls	1967	08/04/69	12/11/71	05/05/73	02/11/00
Batfish	SSN 681	637	Electric Boat	1967	02/09/70	10/09/71	09/01/72	03/17/99
Tunny	SSN 682	637	Ingalls	1967	05/22/70	06/10/72	01/26/74	03/13/98
Parche	SSN 683	637	Ingalls	1968	12/10/70	01/13/73	08/17/74	07/18/05
Cavalla	SSN 684	637	Electric Boat	1968	06/04/70	02/19/72	02/09/73	03/30/98
L. Mendel Rivers	SSN 686	637	Newport News	1969	06/26/71	06/02/73	02/01/75	05/10/01
Richard B. Russell	SSN 687	637	Newport News	1969	10/19/71	01/12/74	08/16/75	06/24/94
Narwhal	SSN 671	671	Electric Boat	1964	01/17/66	09/09/67	07/12/69	01/31/00
Glenard P. Lipscomb	SSN 685	685	Electric Boat	1968	06/05/71	08/04/73	12/21/74	07/11/90
Los Angeles	SSN 688	688	Newport News	1970	01/08/72	04/06/74	11/13/76	02/04/11
Baton Rouge	SSN 689	688	Newport News	1970	11/18/72	04/26/75	06/25/77	01/13/95
Philadelphia	SSN 690	688	Electric Boat	1970	08/12/72	10/19/74	06/25/77	06/30/11
Memphis	SSN 691	688	Newport News	1971	06/23/73	04/03/76	12/17/77	1/20/12
Omaha	SSN 692	688	Electric Boat	1971	01/27/73	02/21/76	03/11/78	10/05/95
Cincinnati	SSN 693	688	Newport News	1971	04/06/74	02/19/77	06/10/78	07/31/95
Groton	SSN 694	688	Electric Boat	1971	08/03/73	10/09/76	07/08/78	11/07/97
Birmingham	SSN 695	688	Newport News	1972	04/26/75	10/29/77	12/16/78	12/23/97
New York City	SSN 696	688	Electric Boat	1972	12/15/73	06/18/77	03/03/79	04/30/97
Indianapolis	SSN 697	688	Electric Boat	1972	10/19/74	07/30/77	01/05/80	12/22/98
Bremerton	SSN 698	688	Electric Boat	1972	05/08/76	07/22/78	03/28/81	———
Jacksonville	SSN 699	688	Electric Boat	1972	02/21/76	11/18/78	05/16/81	———
Dallas	SSN 700	688	Electric Boat	1973	10/09/76	04/28/79	07/18/81	———
La Jolla	SSN 701	688	Electric Boat	1973	10/16/76	08/11/79	10/24/81	———
Phoenix	SSN 702	688	Electric Boat	1973	07/30/77	12/08/79	12/19/81	07/29/98
Boston	SSN 703	688	Electric Boat	1973	08/11/78	04/19/80	01/30/82	11/19/99
Baltimore	SSN 704	688	Electric Boat	1973	05/21/79	12/13/80	07/24/82	07/10/98
City of Corpus Christi	SSN 705	688	Electric Boat	1973	09/04/79	04/25/81	01/08/83	———
Albuquerque	SSN 706	688	Electric Boat	1974	12/27/79	03/13/82	05/21/83	———
Portsmouth	SSN 707	688	Electric Boat	1974	05/08/80	09/18/82	10/01/83	08/18/05
Minneapolis–St. Paul	SSN 708	688	Electric Boat	1974	01/20/81	03/19/83	03/10/84	8/28/2008
Hyman G. Rickover	SSN 709	688	Electric Boat	1974	07/24/81	08/27/83	07/21/84	12/17/07
Augusta	SSN 710	688	Electric Boat	1974	04/01/82	01/21/84	01/19/85	02/11/09
San Francisco	SSN 711	688	Newport News	1975	05/26/77	10/27/79	04/24/81	———
Atlanta	SSN 712	688	Newport News	1975	08/17/78	08/16/80	03/06/82	12/16/99
Houston	SSN 713	688	Newport News	1975	01/29/79	03/21/81	09/25/82	———
Norfolk	SSN 714	688	Newport News	1976	08/01/79	10/31/81	05/21/83	12/11/2014
Buffalo	SSN 715	688	Newport News	1976	01/25/80	05/08/82	11/05/83	———
Salt Lake City	SSN 716	688	Newport News	1977	08/26/80	10/16/82	05/12/84	10/25/06
Olympia	SSN 717	688	Newport News	1977	03/31/81	04/30/83	11/17/84	———
Honolulu	SSN 718	688	Newport News	1977	11/10/81	09/24/83	07/06/85	10/30/07
Providence	SSN 719	688	Electric Boat	1978	10/14/82	08/04/84	07/27/85	———
Pittsburgh	SSN 720	688	Electric Boat	1979	04/15/83	12/08/84	11/23/85	———
Chicago	SSN 721	688	Newport News	1980	01/05/83	10/13/84	09/27/86	———
Key West	SSN 722	688	Newport News	1980	07/06/83	07/20/85	09/12/87	———
Oklahoma City	SSN 723	688	Newport News	1981	01/04/84	11/02/85	07/09/88	———
Louisville	SSN 724	688	Electric Boat	1981	09/24/84	12/14/85	11/08/86	———
Helena	SSN 725	688	Electric Boat	1982	03/28/85	06/28/86	07/11/87	———
Newport News	SSN 750	688	Newport News	1982	03/03/84	03/15/86	06/03/89	———
San Juan	SSN 751	688i[2]	Electric Boat	1983	08/09/85	12/06/86	08/06/88	———

[2] "688i" denotes "Improved LOS ANGELES class."

Name	Hull Nr.	Class	Builder	Shpbldg Prog. FY	Keel Laid	Launched	Comm'd	Decomm'd
Pasadena	SSN 752	688i	Electric Boat	1983	12/20/85	09/12/87	02/11/89	———
Albany	SSN 753	688i	Newport News	1984	04/22/85	06/13/87	04/07/90	———
Topeka	SSN 754	688i	Electric Boat	1984	05/13/86	01/23/88	10/21/89	———
Miami	SSN 755	688i	Electric Boat	1984	10/24/86	11/12/88	06/30/90	03/28/14
Scranton	SSN 756	688i	Newport News	1985	08/29/86	07/03/89	01/26/91	———
Alexandria	SSN 757	688i	Electric Boat	1985	06/19/87	06/23/90	06/29/91	———
Asheville	SSN 758	688i	Newport News	1985	01/09/87	02/24/90	09/28/91	———
Jefferson City	SSN 759	688i	Newport News	1985	09/21/87	08/17/90	02/29/92	———
Annapolis	SSN 760	688i	Electric Boat	1986	06/15/88	05/18/91	04/11/92	———
Springfield	SSN 761	688i	Electric Boat	1986	01/29/90	01/04/92	01/09/93	———
Columbus	SSN 762	688i	Electric Boat	1986	01/09/91	08/01/92	07/24/93	———
Santa Fe	SSN 763	688i	Electric Boat	1986	07/09/91	12/12/92	01/08/94	———
Boise	SSN 764	688i	Newport News	1987	05/25/88	03/23/91	11/07/92	———
Montpelier	SSN 765	688i	Newport News	1987	05/19/89	08/23/91	03/13/93	———
Charlotte	SSN 766	688i	Newport News	1987	08/17/90	10/03/92	09/16/94	———
Hampton	SSN 767	688i	Newport News	1987	03/02/90	04/03/92	11/16/93	———
Hartford	SSN 768	688i	Electric Boat	1988	02/22/92	12/04/93	12/10/94	———
Toledo	SSN 769	688i	Newport News	1988	05/06/91	08/28/93	02/24/95	———
Tucson	SSN 770	688i	Newport News	1988	08/15/91	03/20/94	08/18/95	———
Columbia	SSN 771	688i	Electric Boat	1988	04/21/93	09/24/94	10/09/95	———
Greeneville	SSN 772	688i	Newport News	1989	02/28/92	09/17/94	02/16/96	———
Cheyenne	SSN 773	688i	Newport News	1990	07/06/92	04/16/95	09/13/96	———
Seawolf	SSN 021	021	Electric Boat	1989	10/25/89	06/24/95	07/19/97	———
Connecticut	SSN 022	021	Electric Boat	1991	09/14/92	09/01/97	12/11/98	———
Jimmy Carter	SSN 023	021	Electric Boat	1996	12/12/95	05/13/04	02/19/05	———
Virginia	SSN 774	774	Electric Boat	1998	09/02/99	08/07/03	10/23/04	———
Texas	SSN 775	774	Newport News	1999	07/12/02	04/09/05	09/09/06	———
Hawaii	SSN 776	774	Electric Boat	2001	08/27/04	04/28/06	05/05/07	———
North Carolina	SSN 777	774	Newport News	2002	05/22/04	05/05/07	05/03/08	———
New Hampshire	SSN 778	774	Electric Boat	2003	04/30/07	02/21/08	10/25/08	———
New Mexico	SSN 779	774	Newport News	2004	04/12/08	01/07/09	03/27/10	———
Missouri	SSN 780	774	Electric Boat	2005	09/27/08	11/20/09	07/31/10	———
California	SSN 781	774	Newport News	2006	05/01/09	11/13/10	10/29/11	———
Mississippi	SSN 782	774	Electric Boat	2007	06/09/10	10/13/11	06/02/12	———
Minnesota	SSN 783	774	Newport News	2008	05/20/11	11/03/12	09/07/13	———
North Dakota	SSN 784	774	Electric Boat	2009	05/11/12	09/15/13	10/25/14	———
John Warner	SSN 785	774	Newport News	2010	03/16/13	09/10/14	08/01/15	———
Illinois	SSN 786	774	Electric Boat	2011	6/01/14	08/07/15	———	———
Washington	SSN 787	774	Newport News	2011	11/22/14	———	———	———
Colorado	SSN 788	774	Electric Boat	2012	03/07/15	———	———	———
Indiana	SSN 789	774	Newport News	2012	05/16/15	———	———	———
South Dakota	SSN 790	774	Electric Boat	2013	———	———	———	———
Delaware	SSN 791	774	Newport News	2013	———	———	———	———
Vermont	SSN 792	774	Electric Boat	2014	———	———	———	———
Oregon	SSN 793	774	Electric Boat	2014	———	———	———	———
Montana	SSN 794	774	Newport News	2015	———	———	———	———
Hyman G. Rickover	SSN 795	774	Electric Boat	2015	———	———	———	———
New Jersey	SSN 796	774	Newport News	2016	———	———	———	———
Iowa	SSN 797	774	Electric Boat	2016	———	———	———	———
Massachusetts	SSN 798	774	Newport News	2017	———	———	———	———
Idaho	SSN 799	774	Electric Boat	2017	———	———	———	———

NUCLEAR-POWERED BALLISTIC MISSILE SUBMARINES (SSBN)

Name	Hull Nr.	Class	Builder	Shpbldg Prog. FY	Keel Laid	Launched	Comm'd	Decomm'd
George Washington	SSBN 598	598	Electric Boat	1958	11/01/57	06/09/59	12/30/59	01/24/85
Patrick Henry	SSBN 599	598	Electric Boat	1958	05/27/58	09/22/59	04/11/60	05/25/84
Theodore Roosevelt	SSBN 600	598	Mare Island	1958	05/20/58	10/03/59	02/13/61	02/28/81
Robert E. Lee	SSBN 601	598	Newport News	1959	08/25/58	12/18/59	09/16/60	12/01/83
Abraham Lincoln	SSBN 602	598	Portsmouth	1959	11/01/58	05/14/60	03/11/61	02/28/81
Ethan Allen	SSBN 608	608	Electric Boat	1959	09/14/59	11/22/60	08/08/61	03/31/83
Sam Houston	SSBN 609	608	Newport News	1959	12/28/59	02/02/61	03/06/62	09/06/91
Thomas A. Edison	SSBN 610	608	Electric Boat	1959	03/15/60	06/15/61	03/10/62	12/01/83
John Marshall	SSBN 611	608	Newport News	1959	04/04/60	07/15/61	05/21/62	07/22/92
Thomas Jefferson	SSBN 618	608	Newport News	1961	02/03/61	02/24/62	01/04/63	01/24/85
Lafayette	SSBN 616	616	Electric Boat	1961	01/17/61	05/08/62	04/23/63	08/12/91
Alexander Hamilton	SSBN 617	616	Electric Boat	1961	06/26/61	08/18/62	06/27/63	02/23/93
Andrew Jackson	SSBN 619	616	Mare Island	1961	04/26/61	09/15/62	07/03/63	08/31/89
John Adams	SSBN 620	616	Portsmouth	1961	05/19/61	01/12/63	05/12/64	03/24/89
James Monroe	SSBN 622	616	Newport News	1961	07/31/61	08/04/62	12/07/63	09/25/90
Nathan Hale	SSBN 623	616	Electric Boat	1961	10/02/61	01/12/63	11/23/63	11/03/86
Woodrow Wilson	SSBN 624	616	Mare Island	1961	09/13/61	02/22/63	12/27/63	09/01/94
Henry Clay	SSBN 625	616	Newport News	1961	10/23/61	11/30/62	02/20/64	11/05/90
Daniel Webster [3]	SSBN 626	616	Electric Boat	1961	12/28/61	04/27/63	04/09/64	02/04/93
James Madison	SSBN 627	627	Newport News	1962	03/05/62	03/15/63	07/28/64	11/20/92
Tecumseh	SSBN 628	627	Electric Boat	1962	06/01/62	06/22/63	05/29/64	07/23/93
Daniel Boone	SSBN 629	627	Mare Island	1962	02/06/62	06/22/63	04/23/64	02/18/94
John C. Calhoun	SSBN 630	627	Newport News	1962	06/04/62	06/22/63	09/15/64	03/28/94
Ulysses S. Grant	SSBN 631	627	Electric Boat	1962	08/18/62	11/02/63	07/17/64	06/12/92
Von Steuben	SSBN 632	627	Newport News	1962	09/04/62	10/18/63	09/30/64	02/26/94
Casimir Pulaski	SSBN 633	627	Electric Boat	1962	01/12/63	02/01/64	08/14/64	03/07/94
Stonewall Jackson	SSBN 634	627	Mare Island	1962	07/04/62	11/30/63	08/26/64	02/09/95
Sam Rayburn [4]	SSBN 635	627	Newport News	1962	12/03/62	12/20/63	12/02/64	08/28/89
Nathanael Greene	SSBN 636	627	Portsmouth	1962	05/21/62	05/12/64	12/19/64	12/15/86
Benjamin Franklin	SSBN 640	640	Electric Boat	1963	05/25/63	12/05/64	10/22/65	11/23/93
Simon Bolivar	SSBN 641	640	Newport News	1963	04/17/63	08/22/64	10/29/65	02/24/95
Kamehameha	SSBN 642	640	Mare Island	1963	05/02/63	01/16/65	12/10/65	04/02/02
George Bancroft	SSBN 643	640	Electric Boat	1963	08/24/63	03/20/65	01/22/66	09/21/93
Lewis and Clark	SSBN 644	640	Newport News	1963	07/29/63	11/21/64	12/22/65	08/01/92
James K. Polk	SSBN 645	640	Electric Boat	1963	11/23/63	05/22/65	04/16/66	07/09/99
George C. Marshall	SSBN 654	640	Newport News	1964	03/02/64	05/21/65	04/29/66	09/24/92
Henry L. Stimson	SSBN 655	640	Electric Boat	1964	04/04/64	11/13/65	08/20/66	05/05/93
Geo. Washington Carver	SSBN 656	640	Newport News	1964	08/24/64	08/14/65	06/15/66	03/18/93
Francis Scott Key	SSBN 657	640	Electric Boat	1964	12/05/64	04/23/65	12/03/66	09/02/93
Mariano G. Vallejo	SSBN 658	640	Mare Island	1964	07/07/64	10/23/65	12/16/66	03/09/95
Will Rogers	SSBN 659	640	Electric Boat	1964	03/20/65	07/21/66	04/01/67	04/12/93
Ohio [5]	SSGN 726	726	Electric Boat	1974	04/10/76	04/07/79	11/11/81	———
Michigan [5]	SSGN 727	726	Electric Boat	1975	04/04/77	04/26/80	09/11/82	———
Florida [5]	SSGN 728	726	Electric Boat	1975	01/19/81	11/14/81	06/18/83	———
Georgia [5]	SSGN 729	726	Electric Boat	1976	04/07/79	11/06/82	02/11/84	———
Henry M. Jackson	SSBN 730	726	Electric Boat	1977	01/19/81	10/15/83	10/06/84	———
Alabama	SSBN 731	726	Electric Boat	1978	08/27/81	05/19/84	05/25/85	———
Alaska	SSBN 732	726	Electric Boat	1978	03/09/83	01/12/85	01/25/86	———
Nevada	SSBN 733	726	Electric Boat	1980	08/08/83	09/14/85	08/16/86	———
Tennessee	SSBN 734	726	Electric Boat	1981	06/09/86	12/13/86	12/17/88	———
Pennsylvania	SSBN 735	726	Electric Boat	1983	03/02/87	04/23/88	09/09/89	———
West Virginia	SSBN 736	726	Electric Boat	1984	12/18/87	10/14/89	10/20/90	———
Kentucky	SSBN 737	726	Electric Boat	1985	12/18/87	08/11/90	07/13/91	———
Maryland	SSBN 738	726	Electric Boat	1986	04/22/86	08/10/91	06/13/92	———
Nebraska	SSBN 739	726	Electric Boat	1987	07/06/87	08/15/92	07/10/93	———

Name	Hull Nr.	Class	Builder	Shpbldg Prog. FY	Keel Laid	Launched	Comm'd	Decomm'd
Rhode Island	SSBN 740	726	Electric Boat	1988	09/01/88	07/17/93	07/09/94	———
Maine	SSBN 741	726	Electric Boat	1989	07/03/90	07/16/94	07/29/95	———
Wyoming	SSBN 742	726	Electric Boat	1990	08/08/91	07/15/95	07/13/96	———
Louisiana	SSBN 743	726	Electric Boat	1991	10/23/92	07/27/96	09/06/97	———

[3] Removed from seagoing service and converted to training platform Moored Training Ship (MTS) 626 in 1993.
[4] Removed from seagoing service and converted to training platform Moored Training Ship (MTS) 635 in 1989.
[5] Converted to SSGN.

DEEP SUBMERGENCE RESEARCH VEHICLE

Name	Hull Nr.	Class	Builder	Shpbldg Prog. FY	Keel Laid	Launched	Delivery	Inactivated
Submarine NR-1	———	——	Electric Boat	1965	06/10/1967	01/25/69	10/27/1969	11/21/2008

U.S. Nuclear-Powered Aircraft Carriers (CVNs) and Cruisers (CGNs)

NUCLEAR-POWERED AIRCRAFT CARRIERS

Name	Hull Nr.	Class	Builder	Shpbldg Prog. FY	Keel Laid	Launched	Comm'd	Inactivated
Enterprise	CVN 65	65	Newport News	1958	02/04/58	09/24/60	11/25/61	12/01/12
Nimitz	CVN 68	68	Newport News	1967	06/22/68	05/13/72	05/03/75	———
Dwight D. Eisenhower	CVN 69	68	Newport News	1970	08/15/70	10/11/75	10/18/77	———
Carl Vinson	CVN 70	68	Newport News	1974	10/11/75	03/15/80	03/13/82	———
Theodore Roosevelt	CVN 71	68	Newport News	1980	10/31/81	10/27/84	10/25/86	———
Abraham Lincoln	CVN 72	68	Newport News	1983	11/03/84	02/13/88	11/11/89	———
George Washington	CVN 73	68	Newport News	1983	08/25/86	07/21/90	07/04/92	———
John C. Stennis	CVN 74	68	Newport News	1988	03/13/91	11/13/93	12/09/95	———
Harry S Truman	CVN 75	68	Newport News	1988	11/29/93	09/14/96	07/25/98	———
Ronald Reagan	CVN 76	68	Newport News	1995	02/12/98	03/04/01	07/12/03	———
George H. W. Bush	CVN 77	68	Newport News	2001	09/06/03	10/09/06	01/10/09	———
Gerald R. Ford	CVN 78	78	Newport News	2008	11/14/09	11/09/13	———	———
John F. Kennedy	CVN 79	78	Newport News	2013	08/22/15	———	———	———

NUCLEAR-POWERED CRUISERS

Name	Hull Nr.	Class	Builder	Shpbldg Prog. FY	Keel Laid	Launched	Comm'd	Decomm'd
Long Beach	CGN 09	09	Bethlehem	1957	12/02/57	07/14/59	09/09/61	05/01/95
Bainbridge	CGN 25	25	Bethlehem	1959	05/15/59	04/15/61	10/06/62	09/13/96
Truxton	CGN 35	35	NY Shipbuilding	1962	06/17/63	12/19/64	05/27/67	09/11/95
California	CGN 36	36	Newport News	1967	01/23/70	09/22/71	02/16/74	07/09/99
South Carolina	CGN 37	36	Newport News	1968	12/01/70	07/01/72	01/25/75	07/30/99
Virginia	CGN 38	38	Newport News	1970	08/19/72	12/14/74	09/11/76	11/10/94
Texas	CGN 39	38	Newport News	1971	08/18/73	08/09/75	09/10/77	07/16/93
Mississippi	CGN 40	38	Newport News	1972	02/22/75	07/31/76	08/05/78	07/28/97
Arkansas	CGN 41	38	Newport News	1975	01/17/77	10/21/78	10/18/80	07/07/98

USS CITY OF CORPUS CHRISTI (SSN 705) off Guam

USS NIMITZ (CVN 68) returning to homeport (Naval Air Station North Island, California)
after an 8-month deployment in support of Operation **Iraqi Freedom**, November 2003